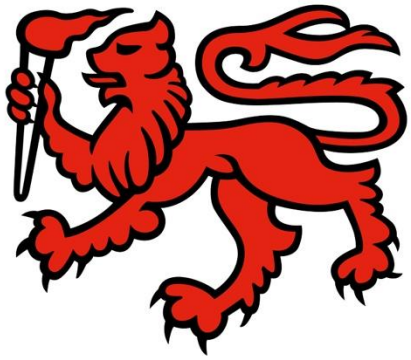

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The potential therapeutic benefits of rhPON2 against *Pseudomonas aeruginosa* infections

by

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Submitted in fulfilment of the requirements for the

Doctor of Philosophy (Medical Studies)

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Abstract

Cystic fibrosis is an autosomal recessive genetic disease caused by mutations in the cystic fibrosis transmembrane conductance regulator (*CFTR*) gene. The CFTR protein channel is responsible for chloride and sodium transport primarily in epithelial cells, and insufficient or dysfunctional CFTR channels cause accumulation of thick and sticky mucus in the airways of people with CF, predisposing the airway to colonisation by microbial respiratory pathogens. In particular, airway colonisation and subsequent chronic infection by *Pseudomonas aeruginosa* is responsible for much of the morbidity and mortality in people with CF. Current antibiotic therapeutic regimes cannot eradicate *P. aeruginosa* infections once they are established, in part at least because this organism is able to form complex and antibiotic resistant multicellular structures called biofilms. Biofilm formation by *P. aeruginosa* and expression of many of its virulence genes is regulated by a cell-to-cell signalling network called quorum sensing, involving the transcriptional effector *N*-3-oxododecanoyl homoserine lactone (3-oxo-C_{12}-HSL). Importantly, the *P. aeruginosa* 3-oxo-C_{12}-HSL can also adversely modulate diverse functions in mammalian host cells, in ways that are important for promoting successful establishment of persistent infection. Our laboratory has been developing a therapy for people with CF, that specifically degrades and inactivates the 3-oxo-C_{12}-HSL signalling molecule, which could be expected to attenuate *P. aeruginosa* pathogenesis by diminishing its virulence and biofilm formation, as well as protecting host cells against adverse effects of 3-oxo-C_{12}-HSL.

In the present study, a recombinant form of the native human lactonase, paraoxonase 2 (rhPON2), was produced in insect cells. When applied extracellularly to stationary-phase cultures of *P. aeruginosa*, rhPON2 diminished expression of two key bacterial quorum sensing-related genes (*lasI* and *lasR*), and significantly reduced biofilm formation. The effect of 3-oxo-C_{12}-HSL on gene expression in human airway epithelial cells was investigated in the absence and presence of rhPON2 using whole-transcriptome RNA-seq analysis. When epithelial cells were treated with 3-oxo-C_{12}-HSL alone, the expression of a diverse set of genes was up-regulated compared to non-treated control cells, including genes whose products are involved in maintaining epithelial barrier integrity and cytoskeletal remodelling and promoting inflammatory responses and apoptosis. In sharp contrast, the expression level of many of these same genes in cells treated with rhPON2 before exposure to 3-oxo-C_{12}-HSLwere similar to levels measured in non-treated controls. Additionally, rhPON2 treatment significantly reduced the release of pro-inflammatory cytokines (IL-8 and IL-6) and diminished apoptosis-related

caspase3/7 activity in airway epithelial cells following exposure to 3-oxo-C_{12}-HSL. The rhPON2 also blocked the 3-oxo-C_{12}-HSL induced hyper-inflammatory response and corresponding higher unfolded protein response (UPR) gene expression in CF cells containing the F508del mutation compared to non-CF cells. Interestingly, the expression of certain genes whose products are involved in redox homeostasis were also differentially regulated in 3-oxo-C_{12}-HSL-treated epithelial cells, highlighting a possible role(s) for oxidative stress in the pathogenesis of *P. aeruginosa*; in turn, this phenomenon was also abrogated by rhPON2. Collectively, these results suggest that rhPON2 can protect epithelial cells from the detrimental effects of 3-oxo-C_{12}-HSL.

Next, rhPON2 therapy was trialled in an *in vivo* acute *P. aeruginosa* infection pulmonary mouse model. Delivery of rhPON2 at the time of infection led to reduced expression of the pro-inflammatory gene *IL-6* and its transcriptional regulator *EGR1* but had little effect on bacterial load 12 hours post infection. These preliminary findings are encouraging but require further in-depth investigation, possibly using a combination of rhPON2 and CF-relevant antibiotic(s) to definitively demonstrate the therapeutic efficacy of rhPON2 *in vivo.*

In summary, the experimental work presented in this thesis demonstrates proof-of-principle that rhPON2 can rapidly hydrolyse and inactivate 3-oxo-C_{12}-HSL, reduce *P. aeruginosa* biofilm formation and expression of some of its key biofilm-related genes. Importantly, rhPON2 prevented many of the detrimental effects of 3-oxo-C_{12}-HSL on mammalian airway epithelial cells, further demonstrating its potential therapeutic usefulness for *P. aeruginosa* infections and people with CF.

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I thank my supervisor, Dr Louise Roddam, for introducing me to Cystic Fibrosis research, and for her guidance and support as I worked towards completing my PhD project. I also thank my supervisory team for their time and considered feedback at different stages of my progress.

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Common abbreviations

Abbreviation	Full form
AHL	acyl homoserine lactone
AJ	adheren junction
ARC	Activity Regulated Cytoskeleton Associated Protein
ATF3	Activating Transcription Factor 3
ATF4	Activating Transcription Factor 4
BAG3	BCL2 Associated Athanogene 3
3-oxo-C_{12}-HSL	*N*-(3-Oxododecanoyl)-L-homoserine lactone
C4HSl	*N*-butyryl-*L*-Homoserine Lactone
CDC42	Cell Division Cycle 42
cDNA	Complimentary deoxyribonucleic acid
CDH1	E-cadherin
CF	Cystic fibrosis
CFTR	Cystic fibrosis transmembrane conductance regulator
CFU	Colony forming units
CHAC1	Glutathione-Specific Gamma-Glutamylcyclotransferase 1
CT	Cycle threshold
CTNNB1	Beta-Catenin
CYCS	Cytochrome C
DMEM	Dulbecco's modified eagle medium
DMSO	Dimethylsulfoxide
DNA	Deoxyribonucleic acid
DNAJA4	DnaJ (Hsp40) Homolog, Subfamily A, Member 4
DNAJB1	DnaJ Heat Shock Protein Family (Hsp40) Member B4-targets misfolded E-cadherin to ERAD
DPBS	Dulbecco's phosphate buffered saline
EDN1	Endothelin 1
EDTA	Ethylenediaminetetraacetic acid
EGR1	Early Growth Response 1
ENac	Epithelial sodium channel
EPS	Extracellular polysaccharide
ER	Endoplasmic reticulum
FEV1	Forced expiratory volume
FBS	Foetal bovine serum
GCLM	Glutamate-Cysteine Ligase Modifier Subunit
GGT1	Gamma-Glutamyltransferase 1
GPX4	Glutathione Peroxidase 4
GSH	Glutathione
HCl	Hydrochloric acid
HSPA1A	Heat Shock 70kDa Protein 1A
HSPA1B	Heat Shock 70kDa Protein 1B
HSPA6	Heat Shock Protein Family A (Hsp70) Member 6
HSPA1L	Heat Shock Protein Family A (Hsp70) Member 1 Like
IL	interleukin
IQGAP1	IQ Motif containing GTPase Activating Protein 1
KD	Knock down
JUN	Jun Proto-Oncogene, AP-1 Transcription Factor Subunit

KO	Knockout
LB	Lysogeny broth
Log	Logarithmic
LPS	Lipopolysaccharide
MAPK	Mitogen-activated protein kinase
µg	microgram
µl	microlitre
µM	micromolar
mg	milligram
mL	Millilitre
mM	Millimolar
MMP	Matrix Metallopeptidase
mRNA	Messenger ribonucleic acid
NADK	NAD Kinase
NaOH	Sodium hydroxide
NFκB	Nuclear factor -κB
ng	nanogram
NGFR	Nerve Growth Factor Receptor
nM	nanomolar
PBS	Phosphate buffered saline
PCR	Polymerase chain reaction
PFU	Plaque forming units
PON	Paraoxonase
PPAR	Peroxisome proliferator activated receptor
PQS	Pseudomonas quinolone signal
P. aeruginosa	Pseudomonas aeruginosa
QS	Quorum sensing
QSI	Quorum sensing inhibition
rhPON2	Recombinant human paraoxonase 2
RAC1	Cell Migration-Inducing Gene 5 Protein
RNA	Ribonucleic acid
RNA-seq	RNA sequencing or whole transcriptome shotgun sequencing (WTSS)
ROS	Reactive oxygen species
RT-qPCR	Reverse transcription-quantitative polymerase chain reaction
S.E.M	Standard error of mean
SDS	Sodium dodecyl sulphate
SDS-PAGE	Sodium dodecyl sulphate polyacrylamide gel electrophoresis
TE	Tris-EDTA buffer
TJ	Tight junction
TLR	Toll-like receptor
TNF	Tumor Necrosis Factor
TER	Transepithelial electrical resistance
U	units
UPR	Unfolded protein response
XBP1	X-Box Binding Protein 1
WT	Wild-type

Chapter One: Introduction and literature review

1.1 Cystic fibrosis

Cystic fibrosis (CF) was first described by the pathologist Dorothy Anderson in 1938 whose autopsies on groups of celiac (and malnourished) children who had died from chronic lung infections revealed underlying pancreatic fibrosis and cystic changes (2). Following her comprehensive description of these observations in the relevant medical literature, it was initially concluded that the pancreatic fibrosis and accompanying malnutrition of these CF children were important factors underlying their acquisition of fatal lung infections. Clinical care of CF patients at that time was therefore directed at correcting their pancreatic insufficiency, which was essentially achieved through nutritional supplementation (with administered pancreatic enzymes, and the like) (3). Despite these efforts, lung infections and the progressive pulmonary function decline still persisted in people with CF, which suggested to some investigators at least that a more complex pathophysiology was involved in cystic fibrosis (3).

At the present time, CF is estimated to affect more than 80,000 people worldwide and is recognised as being a multisystem disorder, where airway infection and associated pulmonary decline are the primary causes of morbidity and much of the mortality in people with CF (4). Importantly, our collective understanding of CF has greatly accelerated over the last 20 years or so, owing in large measure to the breakthrough discovery and subsequent characterisation of the single gene (and associated mutations) responsible for the underlying pathophysiological and clinical features of CF.

1.2 The CFTR gene, protein, and associated mutations

Cystic fibrosis is the most common inherited autosomal recessive disorder affecting Caucasian populations and is caused by mutations in the cystic fibrosis transmembrane conductance regulator (*CFTR*) gene. The human *CFTR* gene was identified and localised to the long arm of chromosome 7 (at 7q31.2) by positional cloning (5-7). Subsequently, the *CFTR* gene was shown to encode a cyclic adenosine monophosphate (cAMP)-stimulated chloride ion channel, which under normal physiological conditions is transported to the apical plasma membrane in airway, intestinal, and exocrine epithelial cells (8). The CFTR protein channel is a member of the so-called ATP binding cassette (ABC) family of transporters, and consists of two transmembrane domains (TMD1, TMD2) that form the channel pore; two nucleotide binding domains (NBD1, NBD2); and a regulatory (R) domain (6, 9, 10). Under normal physiological

conditions, the proper opening and closing of the CFTR channel depends upon protein kinase A (PKA)-mediated phosphorylation of the R domain, and also on the recruitment of adenosine triphosphate (ATP) to the NBD1 and NBD2 domains. The current working model for the operation of the CFTR channel suggests that upon binding ATP, the NBD1 and NBD2 subunits dimerise, leading to opening of the channel pore. Subsequent hydrolysis of ATP results in dissociation of the NBD1 and NBD2 subunits, causing the channel pore to close (Figure 1.1) (11).

The primary function of the CFTR channel appears to be to regulate the flow of chloride ions (Cl^-) in and out of epithelial cells. In addition, CFTR has been shown to be important for regulating the function(s) of other epithelial transport channels, including the sodium ion (Na^+) channels (ENaC). Together, properly working CFTR and CFTR-controlled ENaC channels maintain Cl^-/Na^+ and water homeostasis in cells (12). In the case of a normal airway, the balance in Cl^-/Na^+ and water concentrations creates a well hydrated surface mucus layer across the epithelial cells, which is necessary to facilitate the mucociliary clearance mechanism responsible for removing potential microbial pathogens and other types of foreign particles from the airways (8).

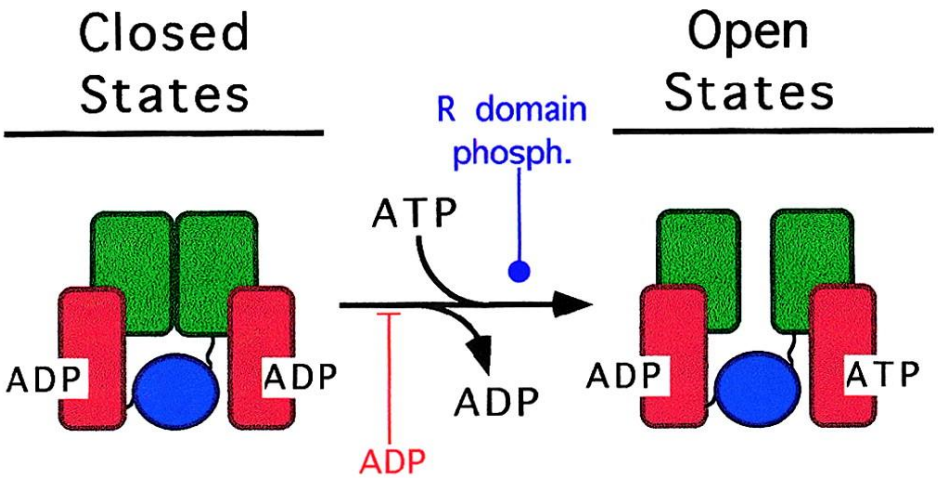


Figure 1.1. Proposed 3D model of the CFTR channel in the plasma membrane

Upon binding ATP, the NBD1 and NBD2 subunits dimerise, leading to the opening of the channel pore. The subsequent hydrolysis of ATP then results in the dissociation of the NBD1 and NBD2 subunits, which causes the channel pore to close. Figure adapted from Sheppard and Welsh (1999) (13).

Over 1,900 different disease-causing mutations have been identified in the *CFTR* gene. These mutations are usually grouped into six classes according to their impact on CFTR protein production and function (Table 1.1) (8, 14). Class I mutations produce no functional CFTR protein and result in the most severe disease phenotype. Class II mutations lead to production of a misfolded CFTR protein, which is prematurely degraded and never reaches the apical membrane. Class II mutations include the most common CF gene mutation, F508del (also referred to as Phe508del), which is found in ~90% of CF peoples worldwide. Class III and IV mutations result in a CFTR channel that reaches the apical cell surface but remains "open" for only short periods of time. Class V mutations affect exon splicing and cause a reduction in the amount and efficiency of CFTR protein channels able to reach the apical membrane. Class VI mutations affect the stability of the mature form of the CFTR protein, resulting in higher protein turnover.

Individually, these different classes of *CFTR* mutations produce no, little, or else dysfunctional CFTR channels in the airways of people with CF. The absence of normally functioning CFTR channels in CF airway leads to the disruption of Cl^- transport; dysregulation of the epithelial sodium channels (ENaC); and eventually to excess Na^+ reabsorption by cells. Consequently, the airways of people with CF accumulate excessive dehydrated sticky mucus secretions, which diminish the operations of the normal mucociliary clearance apparatus and serve as a favourable environment for microbial colonisation/infection (14, 15).

Table 1.1. Classification of CFTR mutations Table adapted from Boyle and Boeck (2013) and O'Sullivan (2009) (8, 14).

Class	**Effect on CFTR**	**Types of mutations**	**Examples**
I	Complete lack of protein production	Nonsense; frameshift, canonical splice	Gly542X; Trp1282X; Arg553X;621+1G→T
II	Protein trafficking defect, ubiquitination and premature degradation of protein in ER/Golgi resulting in either complete absence of functional protein, or substantially reduced levels	Missense; amino acid deletion	Phe508del; Asn1303Lys; Asn1303Lys; Ile507del; Arg560Thr
III	Defective regulation; CFTR present at apical membrane but non-functional (not activated by ATP or cAMP)	Missense; amino acid change	Gly551Asp; Gly551Ser; Gly178Arg; Ser549Asn
IV	Reduced chloride transport through CFTR at the apical membrane; dysfunctional gating	Missense; amino acid change	Arg117His; Arg347Pro; Arg117Cys; Arg334Trp
V	Splicing defect, resulting in reduced levels of functional CFTR	Splicing defect; missense	3849+10kbC→T; 2789+5G→A; 3120+1G→A, A455E
VI	Decreased CFTR stability, low levels of functional protein at apical membrane	Missense; amino acid change	4326delTC; Gln1412X; 4279insA

1.3 Pathogens infecting the CF lung

During early infancy, the airways of people with CF are initially colonised by a range of respiratory pathogens (Figure 1.2) (16), including some important human bacterial pathogens like *Staphylococcus aureus*, *Haemophilus influenza*, and *Burkholderia cepacian*, for example. With increasing age, however, persistent colonisation and infection by one bacterial pathogen in particular, *Pseudomonas aeruginosa*, causes much of the morbidity and most of the mortality in people with CF (17).

Because of the progressive lung damage and function decline associated with persistent airway infection by *P. aeruginosa*, the CF Foundation established therapeutic guidelines recommending the long-term use of varying combinations of anti-pseudomonal antibiotics, often consisting of the aminoglycoside tobramycin, the macrolide azithromycin, and the fluoroquinolone ciprofloxacin (18). These antimicrobial eradication therapies (AET) are administered to CF patients at the time of the first isolation of *P. aeruginosa* from respiratory samples in an attempt to prevent/delay chronic infection (19). While the administration of these anti-pseudomonal antibiotics has in general been remarkably successful as evidenced by the increase in quality of life of CF patients (20), ~80% of people with CF still develop chronic *P. aeruginosa* lung infections before they reach the end of their second decade of life (20). Most CF investigators now generally agree that lung infections by *P. aeruginosa* cannot be eradicated by using these conventional CF antibiotic regimes alone. The persistence of *P. aeruginosa* in the CF airway, and its resistance to antibiotic treatment, seems to be dependent upon its ability to either accumulate antibiotic resistance mutations during therapy, or else alter its growth behaviour to form complex multicellular structures called biofilms that are impenetrable barriers to conventional anti-pseudomonals (21, 22).

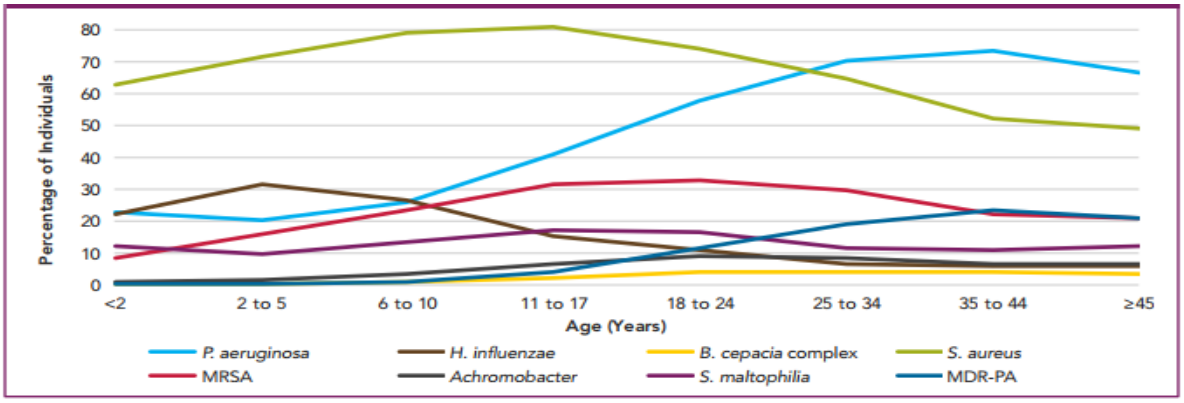


Figure 1.2. Prevalence of bacterial respiratory infections by age group in CF patients 2015

Figure from Cystic Fibrosis Foundation Patient Registry 2015 Annual Data Report (23).

1.4 *P. aeruginosa* as an opportunistic human pathogen

Pseudomonads are usually plant and animal commensals and soil and water dwelling Gram-negative rod-shaped bacteria. Over 200 species have been assigned to the *Pseudomonas* genus based on metabolic and biochemical phenotyping and 16s RNA sequence and cellular fatty acid analysis (24). The genome of the model laboratory *P. aeruginosa* strain PAO1, initially isolated from a burn wound infection, was the first of the pseudomonads to be sequenced, and at 6.3 million base pairs represents one of the largest bacterial genomes sequenced (25). The bulk of its genome compromises of large numbers of open-reading frames (ORFs) with hypothetical functions, as well as genes whose protein products are responsible for DNA synthesis, cell mobility, transport and catabolism, and signal response regulation. Importantly, this organism also appears to possess several genes encoding proteins responsible for its virulence in mammals and antibiotic resistance phenotypes (26).

P. aeruginosa is a serious human opportunistic pathogen that can cause life threating disease in otherwise normal people but especially in those with severe burns (27), diminished immune response systems (28) and other respiratory diseases such as pneumonia and chronic obstructive pulmonary disease (COPD) (29). Some of the well described growth characteristics and virulence mechanisms important for *P. aeruginosa* pathogenesis in mammals/humans are discussed below.

1.5 *P. aeruginosa* quorum sensing, virulence and biofilm formation

One molecular mechanism important for regulating the virulence of *P. aeruginosa* is called quorum sensing (QS). QS is a process whereby *P. aeruginosa* cells use small diffusible transcriptional regulators called auto-inducers (AIs) to sense their overall population size, and in a density-dependent manner synchronize the expression of their genes responsible for their virulence and biofilm-growth phenotype.

QS in *P. aeruginosa* is a complex process, insofar as it seems to be controlled by at least three different yet interconnected quorum sensing signalling systems; the LasR/LasI; RhlR/RhlI; and PQS systems, the first two of which are regulated by acyl homoserine lactone molecules (AHLs, Figure 1.4). AHLs consist of a homoserine lactone ring derived from S-adenosylmethionine (SAM) and an acyl chain donated by an acyl charged carrier protein (acyl-ACP). (30). In the LasR/LasI system, the *lasI* gene product is necessary for synthesis of the AHL, *N*-3-oxo-dodecanoyl homoserine lactone (3-oxo-C_{12}-HSL), which accumulates in the extracellular environment. It is thought that over time a 3-oxo-C_{12}-HSL concentration equilibrium is reached, and subsequently internal AHL binds to and activates its cognate receptor, the transcription factor LasR (30). Together, the 3-oxo-C_{12}-HSL-LasR transcriptional complex is responsible for coordinating expression of a large number of *P. aeruginosa* genes whose products are important for its pathogenesis, including those encoding virulence proteins. Thus for example, the 3-oxo-C_{12}-HSL-LasR transcriptional complex controls the expression of the elastase genes *lasB* and *lasA*, whose products disrupt epithelial barrier integrity and appear to facilitate host cell invasion, (31); the protease gene *aprA*, whose protein product degrades host immune response proteins, including TNFα and complement, which seem to be involved in facilitating the clearance of *P. aeruginosa* cells (32, 33), and the *toxA* gene, which encodes the endotoxin A (34, 35), a lethal toxin that acts to inhibit protein synthesis in mammalian cells (36). It is worthwhile noting here also that the 3-oxo-C_{12}-HSL-LasR complex regulates the expression of the 3-oxo-C_{12}-HSL synthetase *lasI* gene itself, creating a so-called "auto-induction" regulatory loop (Fig. 1.3).

The second quorum sensing system identified in *P. aeruginosa* was the RhlR/RhlI system (30). In this signalling pathway, the *rhlI* gene product, RhlI, synthesises the diffusible effector molecule, *N*-butyryl homoserine lactone (C_4-HSL), which binds to and activates its cognate transcriptional activator, RhlR. Similar to the auto-induction circuit of the LasI/LasR/3-oxo-C_{12}-HSL quorum system, the C_4-HSL-RhlR complex activates the expression of the synthetase

rhlI gene. In addition, the C_4-HSL-RhlR system controls expression of the virulence rhamnolipids (*rhlAB*) and pyocyanin genes, whose products enable *P. aeruginosa* to perform so-called swarming motility (37), and also disrupt epithelial barrier integrity and interfere with host cell functions. (38). Importantly, the discovery that full expression of the *rhlI*/*rhlR*/C_4-HSL pathway required a properly functioning LasI/LasR/3-oxo-C_{12}-HSL signalling system, suggested to investigators that the quorum sensing mechanisms are organised in a hierarchical fashion in *P. aeruginosa*, where the LasI/LasR/3-oxo-C_{12}-HSL quorum sensing system appears to sit above the *rhlI*/*rhlR*/C_4-HSL pathway (30).

More recently, a third quorum sensing mechanism was discovered in *P. aeruginosa*. In this so-called pseudomonas quinolone signalling (PQS) system, the *pqsABCD* genes of this organism are necessary for production of the diffusible transcriptional effector, 2-heptyl-3-hydroxy-4-quinolone (30). The 2-heptyl-3-hydroxy-4-quinolone binds a LysR-type transcriptional regulator, MvfR, and together the quinolone-MvfR complex regulates the expression of the anthranilate synthase (*phnAB*), *pqsABCD*, *lasB*, and *rhlI* genes. Interestingly, the full expression of the PQS system also appears to depend upon both LasR and RhlR activation, which together regulate cellular levels of the MvfR transcriptional activator via differential regulation of the *mvfR* gene (39).

While *P. aeruginosa* has three alternate and inter-dependent (LasR/LasI, RhlR/RhlI, and PQS) quorum sensing signalling systems, the emerging evidence seems to implicate 3-oxo-C_{12}-HSL as the principle transcriptional regulator of its quorum sensing and virulence, as well as its biofilm formation. In this context, Davies and colleagues (40) first reported on the role of 3-oxo-C_{12}-HSL in biofilm formation by *P. aeruginosa*. These investigators showed that *lasI*-defective *P. aeruginosa* cells produced flat and poorly formed biofilms, which was effectively rescued to wild-type levels by the exogenous addition of synthetic 3-oxo-C_{12}-HSL. Since that time, it has become widely known that in *P. aeruginosa* biofilms the bacterial cells are encased in an extracellular polysaccharide (EPS) matrix that consists of extracellular DNA and proteins. In addition, the generation of mature biofilms of this organism appears to proceed in a step-wise fashion, beginning with initial attachment of individual free-growing (planktonic) bacterial cells to a surface; cell-cell signalling and micro-colony formation; synthesis of the EPS matrix; and finally, differentiation into the mature biofilm structure (Figure 1.4). *P. aeruginosa* biofilms are not static, however, and in response to certain environmental cues individual bacterial cells can emerge (or disperse) from the mature biofilm structure, grow as planktonic cells, before once again binding to a surface(s) elsewhere and repeating the biofilm

formation process (Fuqua and Greenberg, 2002). *P. aeruginosa* cells persisting inside biofilm structures are apparently also able to escape a range of stressors, including nutrient limitation and antibiotic challenge(s). In addition, by forming a biofilm, *P. aeruginosa* appears able to evade host immune responses, including phagocytosis, cilia-mediated clearance, and inactivation by opsonising antibodies and complement (41), albeit via mechanisms that are yet to be fully understood. Collectively, the virulence mechanisms and resistance of *P. aeruginosa* biofilms to antibiotic challenge(s) and immune clearance are important factors enabling this organism to cause chronic infections and the characteristic progressive lung tissue injury observed in people with CF (42, 43).

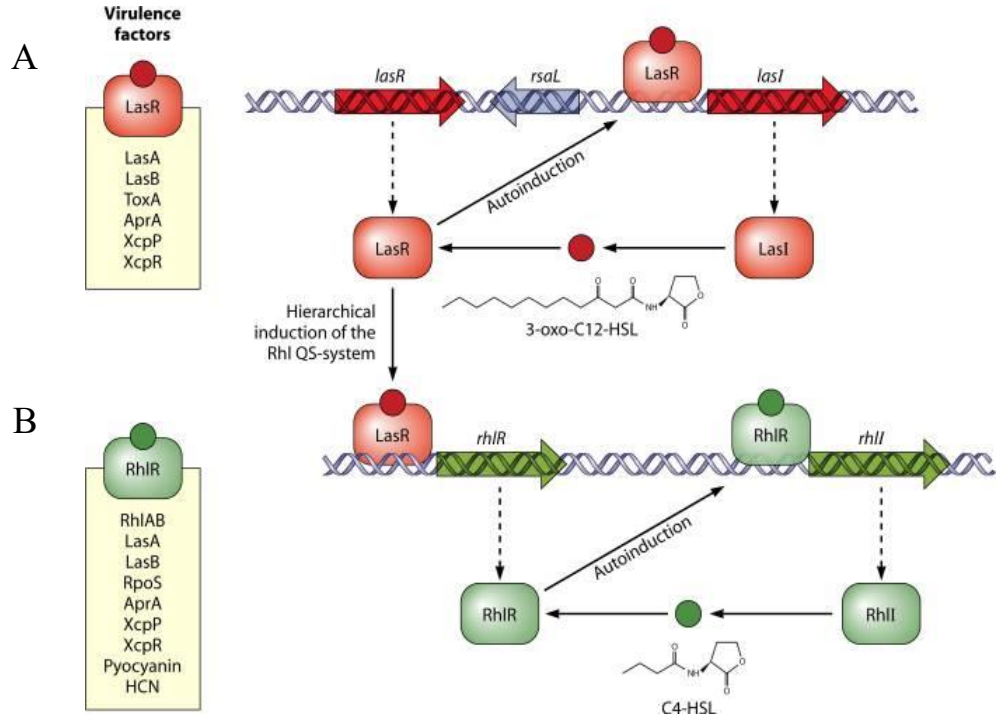


Figure 1.3. The two AHL-mediated quorum sensing systems of *P. aeruginosa*

A) LasI/LasR/3-oxo-C_{12}-HSL pathway. Once a threshold concentration of 3-oxo-C_{12}-HSL is produced, it binds LasR to form the 3-oxo-C_{12}-HSL–LasR complex. This transcriptional complex coordinates the expression of virulence genes (see top left panel) and also regulates expression of *lasI* itself resulting in auto-induction. B) The C_4-HSL binds RhlR to form the C_4-HSL-RhlR complex which regulates expression of virulence genes (see bottom left panel) and of *rhlI* itself resulting in auto-induction. Importantly, the full expression of the *rhlI/rhlR*/C_4-HSL pathway requires a properly functioning LasI/LasR/3-oxo-C_{12}-HSL pathway. Figure adapted from Jimenez *et al*. (2012) (34).

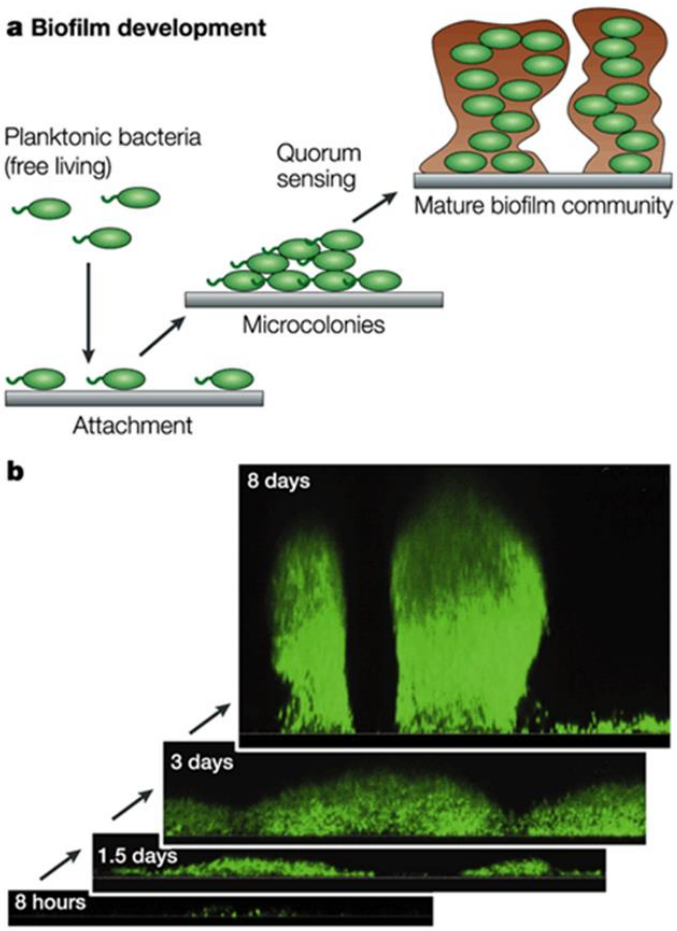


Figure 1.4. Biofilm development

a) The steps involved in biofilm development. b) Confocal image of a *P. aeruginosa* biofilm developing over eight days on a microscope slide. The bacterial cells have been engineered to produce a green fluorescent protein. The mature biofilm is 100 μm high. Figure adapted from Fuqua and Greenberg (2002) (44).

1.6 *P. aeruginosa* quorum sensing molecules are detectable in the CF lung and modulate host cell functions

The importance of quorum sensing-regulated biofilm formation to the pathogenesis of *P. aeruginosa* has been reproducibly demonstrated in several independent *in vivo* murine and rodent models for burns and respiratory infections (45, 46). Animals infected with single *lasI*, *lasR*, *rhlI* and/or doubly defective *lasI/rhlI* quorum sensing bacterial cells, developed milder disease phenotypes compared to those infected with otherwise wild-type *P. aeruginosa* cells (46). More importantly, a study by Erickson *et al.* (2002) (45) provided the initial evidence showing that *P. aeruginosa* quorum sensing might also be active in the airways of CF patients.

These investigators set out to detect mRNA transcripts of several LasI (3-oxo-C_{12}-HSL)-dependent genes in the sputa of CF patients. Using molecular probes specific for the detection of certain transcripts in a northern blot hybridisation analysis, Erickson and colleagues detected the presence of the *toxA*, *lasB*, *lasA*, and *lasR* gene transcripts. Furthermore, these same investigators successfully recovered biologically active AHL signalling molecules from the sputa of CF patients. In an autoinducer bioassay, which involved adding sputa extracts from CF patients to *Escherichia coli* cells transformed with a reporter plasmid carrying genes whose expression responded to the presence of 3-oxo-C_{12}-HSL and C_4-HSL, respectively, these investigators found 3-oxo-C_{12}-HSL at concentrations ranging 1 - 22nM, and C_4-HSL at concentrations ranging from 1 - 5nM. On a similar line of investigation, Collier *et al.* (2002) (47) detected the presence of the quinolone transcription effector, PQS, in sputa collected from CF patients using a combination of acidified ethyl acetate-based extraction and thin layer chromatography methodologies. Although improvements in culture and molecular methodologies make *P. aeruginosa* itself and the mRNA transcripts of several of its virulence genes more readily detectable in sputum samples recovered from people with CF, the precise concentration(s) of its quorum sensing AHLs inside the CF airway remains to be firmly established. Charlton and colleagues (2000) (48), investigating the accumulation of AHLs in *P. aeruginosa* biofilms using chromatography together with mass spectrometry, however, did show that AHLs can reach concentrations as high as 600 μM, at least in biofilms.

Since AHLs can apparently accumulate to high levels in *P. aeruginosa* biofilms and are readily detectable in the airways of people with CF, investigators began suspecting that AHLs might also be capable of interfering with certain host cell functions in ways that facilitate the pathogenesis of this organism. In support of this notion, *P. aeruginosa* 3-oxo-C_{12}-HSL has been demonstrated to enter mammalian cells either by diffusing freely across membranes (49, 50), or else by binding to the transmembrane TR38 taste receptor (51). Furthermore, bacterial 3-oxo-C_{12}-HSL has been demonstrated to disrupt the structural integrity of and dysregulate immune responses and apoptosis in mammalian cells (see Tables 1.2, 1.3 and 1.4), all of which are potentially important contributing factors to the lung tissue damage and function decline associated with persistent *P. aeruginosa* infections in people with CF.

1.7 Bacterial 3-oxo-C_{12}-HSL causes loss of epithelial barrier integrity

Airway epithelial cells play an important role in the innate immune system. They facilitate mucociliary clearance of microorganisms, and produce antimicrobial peptides like lysozyme, lactoferrin, and mucins, as well as secrete chemokines and cytokines that are important for the recruitment of immune cells to sites of infection (52). Epithelial cells also form a selective but permeable barrier consisting of tight junction (TJ) proteins (occulin, and tricellum) that regulate the paracellular transport of ions, and adherent junction (AJ) proteins (E-cadherin and β-catenin) responsible for the initiation and maintenance of cell-cell adhesion (53). It has been argued that *P. aeruginosa* 3-oxo-C_{12}-HSL-induced disruption of epithelial cell integrity and junctions could compromise their innate immune response activities and thereby contribute to the establishment and virulence of this organism in the CF airway. (54).

The 3-oxo-C_{12}-HSL of *P. aeruginosa* has been shown to reduce epithelial barrier function by reducing trans-epithelial electrical resistance (TER) and diminishing the production and distribution of TJ proteins such as occulin and tricellum, as well as adherent junction proteins such as E-cadherin and β-catenin (55-57). The precise mechanism(s) by which 3-oxo-C_{12}-HSL reduces levels of TJ and AJ proteins has not yet been fully characterised but might involve 3-oxo-C_{12}-HSL-induced overstimulation of the mitogen-activated p38- and p42/44 MAPK-dependent pathways (57) and/or cell degrading enzymes like metalloproteinases (MMP-2 and MMP3) (Eum *et al*., 2014). Additionally, in response to injury caused by unabated inflammation, oxidative stress or infection, epithelial cells usually undergo a wound healing process. During this restoration process, the epithelial barrier normally requires extensive re-organisation of the cytoskeleton and cellular junctions, which is in part at least regulated by the Rho family of small GTPases such as Rho, Rac, and Cdc42 that are involved in cell migration (58). Research by Karlsson and colleagues (59) demonstrated that 3-oxo-C_{12}-HSL interacts and binds to IQ-motif-containing GTPase-activating protein (IQGAP1) in human epithelial cells and interferes with Rac1 and Cdc42- dependent reorganization of the actin cytoskeleton and altered cell migration. Thus, for example, they demonstrated that high concentrations of 3-oxo-C_{12}-HSL reduced IQGAP1 protein levels, as well as Cdc42 and Rac1 phosphorylation in epithelial cells, which could further contribute to the loss of cell integrity in the presence of *P. aeruginosa* infection.

Table 1.2. Summary of the effects of 3-oxo-C_{12}-HSL on epithelial barrier function and migration using CaCo-2 intestinal epithelial cell

3-oxo-C_{12}-HSL concentrations	**Disrupts epithelial barrier and cytoskeletal remodelling**	**References**
10 - 300 μM	Reduced expression and distribution of E-cadherin and β-catenin partly via modulation of p38 and p42/44 MAPK pathways Reduced expression and distribution of junction proteins ZO-3 and JAM-A via altered calcium signalling	(57) (56, 60)
200 - 400 μM	Degradation of TJ proteins (occulin and tricellum) via activation of MMP2 and MMP3	(61)
1.3 - 200 μM	Binds to IQGAP. Low doses increased phosphorylation of Rac1/Cdc42, high doses decreased level of phosphorylated Rac/Cdc42	(59)

1.8 3-oxo-C_{12}-HSL-mediated immunomodulation in host cells

In addition to its ability to damage the structural integrity of mammalian cells, the 3-oxo-C_{12}-HSL of *P. aeruginosa* has been demonstrated to cause the dysregulation of host immune responses, as well. Telford and colleagues (1998) (62) demonstrated for the first time that *P. aeruginosa* 3-oxo-C_{12}-downregulated mammalian host immune responses by showing that 3-oxo-C_{12}-HSL significantly lowered the extent to which exogenously applied bacterial lipopolysaccharides (LPS) induced the production of the prototype pro-inflammatory cytokine TNFα in murine peritoneal macrophages. Since that time, several lines of evidence have demonstrated the immunomodulatory effects of 3-oxo-C_{12}-HSL by showing that it significantly diminished levels of stimulated leukocytes and lymphocytes (63-65), peripheral blood mononuclear cells (PBMCs) (66), as well as primary macrophages (67). Together, these data provide further support for the suggestion that the persistence of *P. aeruginosa* infections in the CF airways might in part at least stem from the capacity of its 3-oxo-C_{12}-HSL to lower the levels of host immune surveillance cells (68) (Table 1.3).

In sharp contrast, 3-oxo-C_{12}-HSL also appears to dysregulate the host immune responses by exacerbating the pro-inflammatory responses to bacterial infection. DiMango *et al*. (1995) (69), initially demonstrated a dose-dependent increase in the pro-inflammatory cytokine IL-8 in human airway epithelial cells in response to the *P. aeruginosa* 3-oxo-C_{12}-HSL, leading to the realisation that 3-oxo-C_{12}-HSLs might contribute to the excessive inflammation seen in the CF lung by perhaps over stimulating the IL-8-dependent migration of neutrophils to sites of infection. Similarly, Bryan and colleagues (2010) (70) found that high concentrations of 3-oxo-C_{12}-HSL stimulated the production of several other typical pro-inflammatory cytokines such as IL-8, IL-6, and TNFα in otherwise normal human airway epithelial cells. Interestingly, Mayer and colleagues (2011) (71) showed that 3-oxo-C_{12}-HSL induced a hyperinflammatory response (increased levels of IL-6) in human airway epithelial cells with dysfunctional CFTR channels (because of the F508del mutation in the *Cftr* gene) compared to control, suggesting that the CF lung is exquisitely sensitive to the pro-inflammatory effects of *P. aeruginosa* 3-oxo-C_{12}-HSL. It is noteworthy that high concentrations of 3-oxo-C_{12}-HSL can induce the expression of pro-inflammatory cytokines in other cell types as well, which seems to suggest that this molecule might be inherently pro-inflammatory and that its effects are not cell type specific. Thus for example, high concentrations of 3-oxo-C_{12}-HSL were shown to stimulate production of several pro-inflammatory markers, including IL-1b, IL-6 and IL-8 in human

mesenchymal stem cells (72), IL-8 in human aortic endothelial cells (1) and fibroblast cells (67, 73), and IL-6 and COX-2 in fibroblast cells (73, 74).

Although the principle mechanism(s) by which 3-oxo-C_{12}-HSL induces a pro-inflammatory response in host cells has not be fully investigated, it seems that 3-oxo-C_{12}-HSL can cause the overactivation of the inflammatory response by interfering with any one of a number of diverse cellular signalling pathways. Numerous investigators showed that 3-oxo-C_{12}-HSL induced the phosphorylation of certain of the mitogen activated protein (MAP) kinases (ERK1/2, for example) otherwise involved in regulating cell growth and differentiation, which in turn led to the activation and nuclear localisation of NF-kB transcription factor and to production of NF-kB-dependent pro-inflammatory cytokines in human airway epithelial cells (1, 71, 75). Researchers have also demonstrated that 3-oxo-C_{12}-HSL interacts with members of the nuclear hormone receptor family, peroxisome proliferator response activator receptor (PPAR), which can modulate NF-κB to regulate inflammatory gene expression (76-78). Intriguingly, Kim *et al*. (2011) showed that 3-oxo-C_{12}-HSL was also capable of inducing the unfolded protein response (UPR) in human aortic endothelial cells (HAECs). It will be recalled that the UPR is a cellular stress response related to endoplasmic reticulum (ER) stress. Briefly, the UPR has three ER stress sensors, namely, ATF6, PERK and Ire1α, which under normal physiological conditions are in an inactive state and are bound by the immunoglobulin heavy chain protein (BIP) chaperone. Activation of the unfolded protein response (UPR) pathway occurs when misfolded and unfolded proteins accumulate in the lumen of the ER; in turn, BIP dissociates from the ER stressors allowing them to either mediate the inhibition of protein synthesis (relieving ER stress), or else activate accessory transcription factors like activating transcription factor 4 (ATF4), ATF3, ATF6, and spliced X box-binding protein (XBP) that control the expression of genes whose protein products increase the protein folding capacity of the ER (Figure 1.5) (79). Previous studies by Gargalovic *et al*. (2006) (80, 81) demonstrated that the UPR transcription factors ATF4 and XBP1 are essential mediators of inflammation, since siRNA knockdown ATF4 and/or XBP1 in human aortic endothelial cells significantly diminished *IL-8* and *IL-6* gene expression compared to mock transfected cells. Thus, *P. aeruginosa* 3-oxo-C_{12}-HSL might be able to cause dysregulation of host immune responses and sustain a pro-inflammatory response indirectly by inducing the unfolded protein response, as well.

Collectively, these data show that *P. aeruginosa*'s 3-oxo-C_{12}-HSL can cause dysregulation of host immune responses towards its colonisation/infection by lowering levels of host immune

surveillance cells and by directly/indirectly exacerbating pro-inflammatory responses, all of which are likely to be important in determining the ability of *P. aeruginosa* to avoid immune clearance and the extent of airway epithelia damage and subsequent lung injury in people with CF.

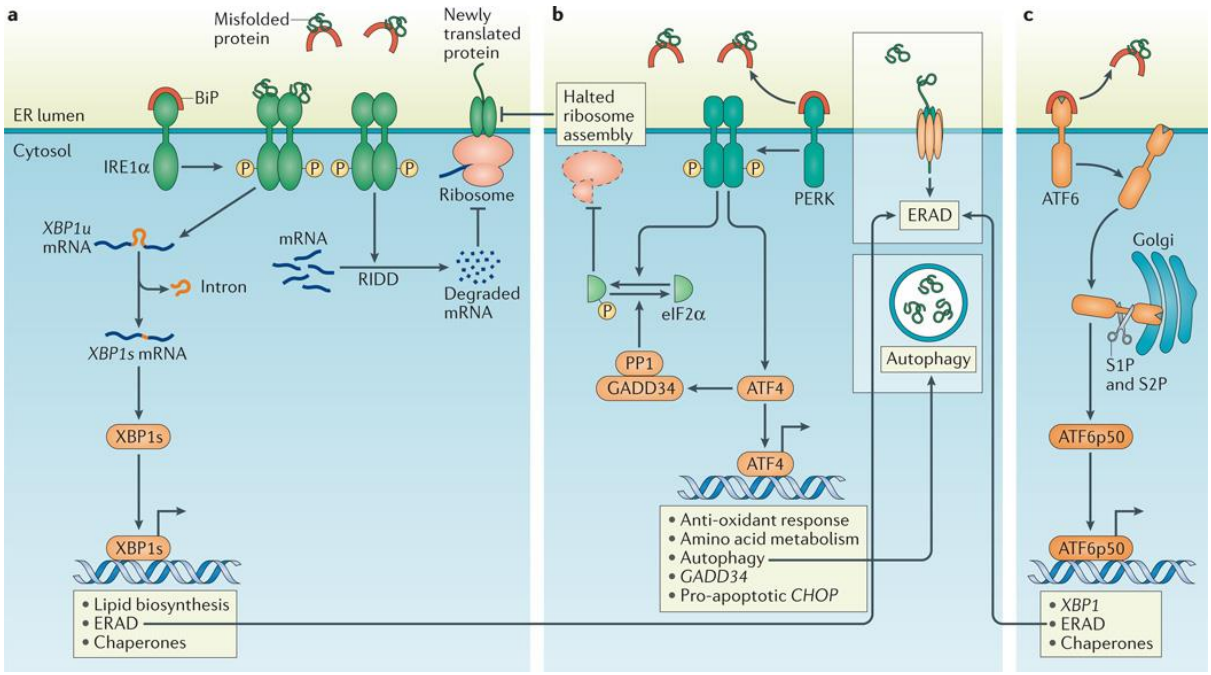


Figure 1.5. The three branches of the UPR pathway

a) Ire1α branch results in increasing the ER protein folding capacity and ERAD; b) PERK branch results in inhibiting translation to promote cell survival or results in apoptosis and autophagy; c) ATF6 branch in increasing the ER protein folding capacity and ERAD to remove misfolded proteins. Figure adapted from Grootjans *et al*. (2016) (79).

Table 1.3. Summary of the effects of 3-oxo-C_{12}-HSL on host inflammatory pathways

3-oxo-C_{12}-HSL concentration	Cell type	Immunomodulation	Reference
30 and 100 μM	lHAEo$^-$ cells	Dose dependent increase in IL-8 secretion	(69)
100 μM	Human airway epithelial cells	Increased expression and production of IL-8 via induction of NF-kB via phosphorylation of ERK/MAPK	(75)
10 and 100 μM	Lung fibroblasts	Increase Cox-2 via induction of NF-kB	(74)
1 μM	Mouse skin	Increase IL-6, Cox-2 via induction of NF-kB	(82)
100 μM	NIH 3T3 fibroblast cells	Increase in expression of IL-8, IL-6 and Cox-2 gene expression	(73)
100 μM	Polymorphonuclear neutrophils (PMNs)	Migration toward 3-oxo-C_{12}-HSL, increases phagocytosis and upregulates CD11b/CD18 and CD16/CD64 receptors to prevent biofilm formation	(83), (84)
50 μM	Human aortic endothelial cells	Increase in inflammatory genes expression e.g. IL-8 Over-representation of NF-κB MAPK signalling pathway. Activates UPR pathway	(1)
50 μM	Lung fibroblast cells WI-38	Increase in expression of IL-8 gene	(67)
100 μM	Human airway epithelial cells	3-oxo-C_{12}-HSL induces pro-inflammatory cytokine IL-6 and TNFα production in a calcium-dependent manner, Further increased IL-6 production in CF cell line Over-representation of MAPK and NF-κB signalling pathway	(71)

6.25 - 12.5 μM **50-100μM**	Murine mast cells P815 HUVE-12	Increased IL-6 production at lower concentrations but steadily reduced IL-6 production at high concentration	**(85)**
50 μM	Human mesenchymal stem cells (bone marrow derived)	Increase in IL-1b, IL-6 and IL-8	(72)
>25 μM	Human leukocytes	Reduces LPS induced IL-12	(62)
40 μM	Murine peritoneal macrophages	Reduces LPS induced TNFα	(62), (67),
> 50 μM	Con A activated PBMCs	Reduces LPS induced TNFα secretion and IL-2 release inhibited cell proliferation and IL-2 release	(66)
50 and 100 μM	Macrophages, human PBMCs	Reduces TNFα secretion	(86)
5 μM	T-cells	Reduces cytokine secretion IFγ and IL-4	(64, 65)
10 and 25 μM	Monocytes (U937 and THP1), and T-cell lines (Jurkat)	Induction of HLA-G by 3-oxo-C_{12}-HSL is p38/CREB and IL-10 dependent	(87)
50 or 100 μM	Mouse embryonic fibroblasts	Activates NF-κB increasing IL-6 and IL-8 gene expression but inhibits cytokine secretion	(88)
100 μM	Macrophages, fibroblasts *in vivo*	Disrupts NF-κB signalling induced by LPS and TNFα	(89)
100 μM	Human macrophages	Increased phagocytic activity through p38 MAPK pathway	(90)
18.24 μM	Con A activated PBMCs	Inhibited cell proliferation and IL-2 release	(66)
50 μM	LPS-stimulated murine RAW264.7 macrophages and peritoneal macrophages	Increased major anti-inflammatory cytokine, IL-10	(91)

1.9 3-oxo-C_{12}-HSL induces apoptosis in host cells

At sites of colonisation and infection, *P. aeruginosa* 3-oxo-C_{12}-HSL can further contribute to host cell damage by inducing programmed cell death, or apoptosis, which is believed by many investigators to be a strategy employed by this organism to help it evade the host immune responses.

Tateda *et al.* (2003) (92) were the first to demonstrate that concentrations greater than 10 μM of 3-oxo-C_{12}-HSL induced apoptosis in mammalian cells. These investigators found that 3-oxo-C_{12}-HSL increased cellular levels of several apoptotic effectors and biomarkers, including caspase 3 and 8, phosphotidylserine, and histone-associated DNA fragments in neutrophils and macrophages. Since the external 3-oxo-C_{12}-HSL signal resulted in the activation of caspase 8, which it will be recalled is also responsible for activating other effector caspases like 3/7, for example, these results were interpreted as suggesting that 3-oxo-C_{12}-HSL induced apoptosis via the so-called *extrinsic* pathway (Figure 1.6). In contrast, other researchers demonstrated that 3-oxo-C_{12}-HSL induced apoptosis of host cells by disrupting the mitochondrial membrane potential leading to the activation of caspase 9, which functions in the *intrinsic* (mitochondrial) apoptosis pathway (93, 94). In addition, overproduction of the anti-apoptotic Bcl-2 proteins in T-lymphocytes abrogated the apoptotic effects of 3-oxo-C_{12}-HSL, further confirming that 3-oxo-C_{12}-HSL induced apoptosis via the intrinsic pathway (93). Interestingly, 3-oxo-C_{12}-HSL might also be able to trigger the apoptosis of host cells by activating both the extrinsic and intrinsic pathways simultaneously. Schwarzer and colleagues (2012) (95) demonstrated that 3-oxo-C_{12}-HSL induced apoptosis in the human airway epithelial Calu-3 cells, for example, by increasing levels of both capsase-8 and caspase-9 in these cells.

Besides inducing apoptosis in mammalian cells via extrinsic and/or intrinsic pathways, 3-oxo-C_{12}-HSL might also exert its apoptotic effects through other cellular stress signalling pathways. Thus for example, 3-oxo-C_{12}-HSL induced apoptosis in several breast cancer cell lines by down-regulating the expression of the signal transducer and activator of transcription 3 (STAT3) pathway (96), and in intestinal epithelial cells by suppressing Akt phosphorylation (97). In murine fibroblasts and human vascular endothelial cells (HUVEC) (73) and mast cells (85), 3-oxo-C_{12}-HSL induced apoptosis by increasing intracellular calcium release from stores by acting on the inositol triphosphate (IP3) receptors in the ER. Furthermore, Kim and colleagues (2011) showed that high concentrations of 3-oxo-C_{12}-HSL triggered ER stress leading to the activation of the UPR. These authors showed that 3-oxo-C_{12}-HSL increased the

expression of several UPR genes ATF3, XBP, and the DNA damage inducible transcript 3 (DDIT3/CHOP) gene, whose products are also involved in triggering apoptosis. In this context, overproduction of CHOP has been shown to induce cell cycle arrest and apoptosis by activating the expression of the pro-apoptotic BH3-only (BIM) protein, which plays a role(s) in the intrinsic apoptosis pathway (98). Altogether, it is clear that 3-oxo-C_{12}-HSL is a potent inducer of apoptosis in different cell types, which can proceed via multiple pathways.

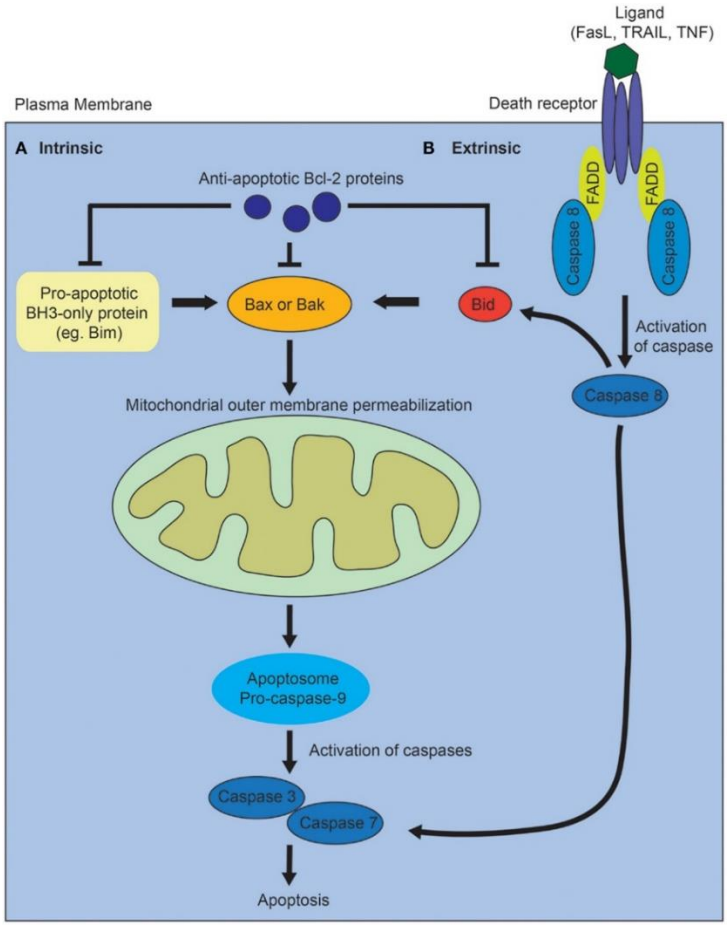


Figure 1.6. Intrinsic and extrinsic apoptosis pathways.

The intrinsic pathway involves the pro- apoptotic BH_3 proteins, which activate the Bax or Bak resulting in outer mitochondrial membrane permeabilisation and activation of caspase 3 and 7 leading to apoptosis. In the extrinsic pathway, ligands such as Fas, TNF or TNF related apoptosis –inducing ligand (TRAIL) bind to death receptors resulting in the recruitment of Fas-associated death domain protein (FADD) and activation of caspase 8, which directly activates caspases 3 and 7. The two pathways can interact via caspase 8 mediated cleavage of BID to the truncated active form tBID, which then activates the Bcl-2 proteins Bax and BaK. Figure adapted from Ho and colleagues (2014) (99).

Table 1.4. Bacterial 3-oxo-C_{12}-HSL promotes apoptosis in host cells

3-oxo-C_{12}-HSL concentrations	Cell type	Apoptosis and cytotoxicity	Reference
12 – 50 μM	Murine bone marrow derived macrophages, neutrophils and monocytic cell lines	Cytotoxic leading to apoptosis	(92) (100)
100 μM	Murine fibroblasts and human vascular endothelial cells	increases in intracellular calcium levels and leads to apoptosis	(73)
>10 μM	Airway epithelial cells	Triggers apoptosis independent of presence of CFTR	(101)
50 μM	Human mesenchymal stem cells	Induced apoptosis	(72)
100 μM	Murine mast cells	Inhibited cell proliferation and induced apoptosis	(85)
100 μM	Breast carcinoma cells	Induced apoptosis in correlated with down-modulation of STAT3	(96)
30 μM	Caco-2 cells, intestinal epithelial cells	reduce viability accompanied by apoptosis via the suppression of phosphorylation by Akt	(97)
1-100μM **25-100μM**	Human Jurkat T lymphocytes Mouse embryonic Fibroblasts	apoptosis by activation of the intrinsic mitochondrial apoptosis pathway	(93) (94)
50μM	HAEC (human aortic endothelial cells)	Induces UPR	(1)

1.10 Targeting the QS system to prevent *P. aeruginosa* virulence, biofilm formation, and host cell function modulation.

The importance of 3-oxo-C_{12}-HSL in coordinating virulence gene expression and antibiotic resistant biofilm formation by *P. aeruginosa*, as well as its widely reported destructive effects on host epithelial membrane barriers, dysregulation of immune responses and induction of apoptosis, has led researchers to consider developing therapeutic strategies that would attenuate the pathogenesis of *P. aeruginosa* by specifically targeting its 3-oxo-C_{12}-HSL signalling molecule. Since these so-called quorum sensing inhibitor (QSI) strategies would be targeting the active 3-oxo-C_{12}-HSL signalling molecule itself and not bacterial growth, *per se*, it has been widely argued that these strategies would be less likely to create the sorts of selection pressure(s) often driving the accumulation of resistance mutations toward so many different classes of conventional antibiotics (102). In this context, there are very few reports in the literature describing the effects of a combined QSI plus conventional antipseudomonal therapy on the pathogenesis of *P. aeruginosa* cells (103, 104). Our laboratory has demonstrated that blocking 3-oxo-C_{12}-HSL signalling by *P. aeruginosa* made the bacterial cells more susceptible to the growth inhibitory effects of certain anti-pseudomonals like tobramycin, for example. It seems more likely, therefore, that future strategies to attenuate the pathogenesis of *P. aeruginosa* might prove more effective if they involve the use of certain types of QSIs in combination with a conventional antibiotic(s).

Current strategies being pioneered that target quorum sensing by *P. aeruginosa* and the 3-oxo-C_{12}-HSL signalling molecule, include those that act either by inhibiting the synthesis of AHLs, block the AHLs from binding to their bacterial cognate receptors for transcription, or else degrade the AHLs signals themselves (102).

In initial attempts to develop a strategy to prevent AHL synthesis, Hoang and Schweizer (1999) (105) found that low concentrations of the commercially used polychlorophenoxyphenol triclosan inhibited fatty acid biosynthesis, which of course is required for the synthesis of bacterial AHLs. These authors demonstrated that triclosan inhibited the enoyl-acyl-carrier protein reductase (Fab1), which diminished the production of 3-oxo-C_{12}-HSL and C_4-HSL by *P. aeruginosa*. However, these authors also found that *P. aeruginosa* possess multiple multidrug efflux pumps that act to efflux triclosan from cells, thereby mitigating its potential therapeutic benefits (106). The anti-pseudomonal macrolide antibiotic, azithromycin, is another potential AHL synthesis inhibitor (107-109) demonstrated that azithromycin decreased

the transcription of AHL synthesis and reduced *P. aeruginosa* biofilm formation, possibly by targeting the translation machinery in bacterial cells. Long-term macrolide use in inflammatory airway diseases has been linked to emergence of antibiotic resistance (110) and can be cytotoxic to human liver cells, however (111).

Blocking 3-oxo-C_{12}-HSL-dependent virulence gene expression and biofilm formation might also be achieved by using compounds that competitively inhibit 3-oxo-C_{12}-HSL binding to its cognate receptor. Thus, for example, naturally occurring metabolites like furanones isolated from the marine red macro alga, *Delisea pulchra*, successfully inhibited quorum sensing by *P. aeruginosa* in a murine pulmonary infection model. However, currently available furanones are far too reactive, and are too toxic for any potential therapeutic use in humans (112). Additionally, a study by Maeda *et al*. (2012) (113) showed that the use of these sorts of chemical QSIs like furanones supplied a selective pressure similar to conventional antibiotics and lead to the emergence of QSI-resistant mutants in populations of *P. aeruginosa* cells, which involved the upregulation of the MexAB-OprM drug efflux pump of this organism. Another naturally occurring inhibitor of 3-oxo-C_{12}-HSL binding is *Allium sativum*, or garlic. The allicin component of garlic, has demonstrated broad antimicrobial properties and can interact directly with the some QS receptors (114). Rasmussen *et al*. (2005) (115) demonstrated that garlic reduced the expression of 92 out of 167 QS-regulated genes in *P. aeruginosa* and biofilm formation by this organism. In accordance with these data, Bjarnsholt and colleagues (2015) (103) demonstrated that garlic extracts increased the antibiotic susceptibility of *P. aeruginosa* biofilms *in vitro* and also enhanced the clearance of *P. aeruginosa* in a chronic mouse model of infection. Encouraged by these data, a small pilot randomized human trial involving consumption of garlic was conducted. While the results of that human trial did show a trend in improving the clinical outcome of CF patients relative to their forced expiratory volume (FEV1) function scores and weight gain, those data did not reach statistical significance, and certain AHLs were still able to detected in patient plasma and sputa samples (116).

Antibodies can also be developed that specifically interfere with AHL accumulation and inhibit bacterial quorum sensing. Kaufmann *et al*. (2006) (117) were the first to demonstrate that lactam containing haptens coupled to AHL acyl chains, were able to induce production of AHL-specific monoclonal antibodies. Using the monoclonal antibody, RS2-1G9, they showed that it was specific to the *P. aeruginosa* 3-oxo-C_{12}-HSL, and inhibited QS signalling and production of a secondary metabolite toxin, pyocyanin, by this organism. In addition, RS2-1G9 protected murine bone marrow derived macrophages from 3-oxo-C_{12}-HSL-induced apoptosis

(118). Miyairi *et al.* (2006) (119) also demonstrated that active immunisation with BSA-conjugated 3-oxo-C_{12}-HSL increased the survival of mice following an intranasal challenge with *P. aeruginosa*. Thus, together these data show that antibodies that interfere with bacterial AHL accumulation can inhibit quorum sensing and diminish the virulence of *P. aeruginosa*. While antibodies can be produced to specifically target bacterial 3-oxo-C_{12}-HSL, monoclonal antibodies can potentially trigger innate and adaptive immune responses (120). Infusion of monoclonal antibodies in certain patient cohorts led to acute reactions such as IgE mediated anaphylaxis and the so-called cytokine release syndrome (CRS) (121), which appears to be associated with elevated circulating levels of several cytokines such as IL-6 resulting in potential life-threatening toxicity (122). Monoclonal antibody therapy could be problematic in patients with CF, since they usually have elevated levels of pro- inflammatory cytokines circulating in their lungs, which conceivably could be further exacerbated by these types of antibody mediated anti-pseudomonal strategies (123).

Another way to inactivate bacterial AHLs is by enzymatic degradation, and lactonases have been the most extensively studied AHL degrading enzymes to date. Lactonases act by hydrolysing the ester bond of the homoserine lactone ring, thereby preventing the signalling molecule from binding its cognate receptor (124, 125). Lactonases are produced by several bacterial species, lower eukaryotes, plants and animals. Dong *et al.* (2001) (125) initially demonstrated the potency of lactonase inhibitors by showing that the AiiA lactonase from *Bacillus sp.* could inactivate AHL molecules *in vitro*. Moreover, overproducing the AiiA of *Bacillus* in *P. aeruginosa* cells showed that it reduced the production and release of AHLs by this organism and consequently decreased expression and production of several *P. aeruginosa* virulence factors such as elastase, pyocyanin and rhamnolipids, and prevented its swarming motility (126). Migiyama *et al.* (2013) (127) demonstrated the efficacy of using the *Mycobacterium testaceum* AiiM lactonase for controlling an acute *P. aeruginosa* lung infection in a mouse model. They showed that mice infected with AiiM-producing *P. aeruginosa* cells yielded lower levels of pro-inflammatory cytokines in their bronchoalveolar lavage (BAL) fluid, experienced less lung tissue damage, and had improved survival rates, compared to those animals infected with otherwise wild-type *P. aeruginosa* cells. These results provided proof-of-principle that lactonases can reduce lung injury and inflammation *in vivo*, at least in the mouse model. In this context, humans also possess endogenous lactonases (called paraoxonases) that can potentially inactivate bacterial AHL molecules and protect against 3-

oxo-C_{12}-HSL effects on mammalian cells, which our laboratory has begun exploring as a potential extracellularly therapeutic for people with CF.

1.11 Human Paraoxonases (PON1, PON2 and PON3)

The human paraoxonase family consists of three lactonases that play protective roles in inflammatory diseases such as atherosclerosis. Paraoxonase 1 (PON1) was the first paraoxonase to be identified. Mazur *et al*. (1946) (128) showed that extracts from human and rabbit tissues could hydrolyse the phosphorus-fluorine bond of alkyl-fluoro-phosphates. Further studies by Aldridge *et al.* (1953) (129) then identified a serum esterase from various animals that could hydrolyse the toxic metabolite paraoxon (PO), which was subsequently called paraoxonase. Since that time, Primo-Parmo *et al*. (1996) (130) described two additional members of the paraoxonase family, PON2 and PON3. The PON1-3 genes are located on the long arm of human chromosome 7 and have 70% nucleotide sequence homology. While PON2 and PON3 do not hydrolyse paraoxon, all PONs possesses calcium-dependent lactonase activity (131). Yang *et al*. (2005) (132) demonstrated that serum collected from humans, mice and other mammals could hydrolyse bacterial AHLs. Further, CHO cells transformed to overexpress any one of the three mouse PON genes also had significantly higher AHL hydrolysis activity compared to non-transformed CHO cells (132).

PON1 and PON3 are now known to be expressed in the liver and secreted in sera where they associate with high density lipoproteins (HDLs) and appear to play protective role(s) in atherosclerosis (133). On the other hand, PON2 is not normally present in the circulation but instead is expressed intracellularly and often found bound to nuclear and mitochondrial membranes (134). It is noteworthy that lung epithelial cells express high levels of intracellular PON2, and that PON2 has the highest lactonase activity against 3-oxo-C_{12}-HSL of all three human PONs (131, 135, 136).

1.12 PON2 has anti-oxidant properties

All three PONs possess anti-oxidative properties and appear to protect against coronary artery disease (CAD). For instance, PON1 and PON3, which are secreted in sera, associate with high density lipoproteins (HDL). In addition, the capacity of HDL to control peroxidation of HDL and LDL seems dependent on levels of PON1 and PON3 (137). PON1 directly reduced macrophage and aortic oxidative stress (138) and overproduction of PON1 in ApoE-deficient mice protected against the atherosclerotic process (139). PON2 is an intracellular protein and it has been shown to protect against oxidative stress in vascular cells. Thus, for example, Horke

and colleagues (2007) (134) demonstrated that overexpression of PON2 reduced reactive oxygen species (ROS), whereas its knockdown significantly increased ROS levels in vascular cells. PON2 appears to exert its anti-oxidant function by controlling the amounts of superoxide (O_2^-) being released by the mitochondrial complexes I and III by acting on coenzyme Q10 within cells (140).

1.13 PON2 has anti-inflammatory and immunomodulatory properties

PON2 has also been shown to possess anti-inflammatory properties. Schweikert and colleagues (2012) (141) demonstrated that PON2 decreased *P. aeruginosa* pyocyanin-induced NF-kB activation and IL-8 cytokine production in several human cell lines. In addition, Kim *et al.* (2011) demonstrated that siRNA silencing of PON2 caused the upregulation of the pro-inflammatory genes IL-8 and Cox-2, as well as some of the UPR-related ATF3, XBP1s and DDIT3 genes in 3-oxo-C_{12}-HSL-treated human airway epithelial cells. These same investigators also showed conversely that PON2 overproduction ameliorated the inflammatory and UPR responses in 3-oxo-C_{12}-HSL treated HeLa cells. Consistent with these PON2 immunomodulatory effects, Devarajan and colleagues (2011) (140) reported that PON2 might also play a role in the innate immune response clearance of *P. aeruginosa*. They demonstrated that the clearance of *P. aeruginosa* from the lungs, liver, and spleen of PON2-knockout mice was reduced significantly compared to otherwise wild-type mice.

1.14 PON2 has both anti-apoptotic and pro-apoptotic properties

Several studies have reported on the anti-apoptotic properties of PON2. Horke and colleagues (2007) (134) showed that PON2 protected endothelial cells from ER stress, oxidative stress and apoptosis. Kim and colleagues (2011) (1) demonstrated that 3-oxo-C_{12}-HSL induced caspase 3 activation in PON2 depleted HAECs compared to control cells. In sharp contrast, more recent studies reported that PON2 *activated* apoptosis in response to 3-oxo-C_{12}-HSL in MEFs, 293T cells and human bronchial epithelial cells overexpressing PON2, and lung cancer cell lines (142, 143). The contradictory role of PON2 in apoptosis in response to 3-oxo-C_{12}-HSL, however, may be dependent the concentration of intracellular PON2 and cell type. It has been suggested that intracellular PON2 hydrolyses the 3-oxo-C_{12}-HSL into 3-oxo-C_{12}-HSL-acid, rapidly (within minutes) acidifying the cytosol and mitochondria triggering Ca^{2+} liberation and p38 and elongation initiation factor 2 alpha (eIF2α) phosphorylation resulting in apoptosis (144).

Given the intrinsic lactose activity of human PON2, together with its anti - inflammatory, - oxidant and - apoptotic properties, it was reasoned that a recombinant human PON2 administered extracellularly could be effective at diminishing the virulence and biofilm formation of *P. aeruginosa*, as well as much of the effects of its 3-oxo-C_{12}-HSL on mammalian cells.

1.15 Hypothesis and Aims

It was hypothesised that recombinant human PON2 (rhPON2) applied extracellularly would diminish *P. aeruginosa* biofilm formation, as well as protect host cells from the detrimental effects of its 3-oxo-C_{12}-HSL. It was anticipated therefore that the results of this study would provide evidence demonstrating the potential of extracellularly applied rhPON2 as an alternative therapeutic strategy for people with CF.

In this study recombinant human PON2 was produced using a baculovirus-mediated expression system (131). Next, the ability of the rhPON2 to diminish the expression of biofilm-related genes in and reduce biofilm formation by *P. aeruginosa* was investigated.

In *in vitro* mammalian cell culture models, a global transcriptome analysis using RNA sequencing (RNA-seq) was used to determine whether rhPON2 could prevent the detrimental effect of 3-oxo-C_{12}-HSL on airway epithelial cells. Based on these results, RT-qPCR was used to determine whether rhPON2 could prevent the expression of key inflammatory and UPR genes in two CF cell culture models; a non-isogenic pair, NuLi-1 (non-CF) and CuFi-1 (CF containing F508del mutation), and an isogenic cell pair, wild-type CFTR Calu-3 cells compared to Calu-3 cells with reduced CFTR expression.

Lastly, an *in vivo* murine acute *P. aeruginosa* pulmonary infection model was developed to determine whether administered rhPON2 could protect infected mice from bacterial-induced inflammation.

Chapter Two: Recombinant human PON2 (rhPON2) reduces expression of key *P. aeruginosa* QS genes and bacterial biofilm formation

2.1 Introduction

Several methods have been published describing the successful production of recombinant human PON2 (rhPON2) in various cell types, including in human, insect and bacterial cells. Rosenblat *et al.* (2003) (145) overexpressed the human *PON2* gene in stably transfected HEK293 mammalian cells and demonstrated that production of the active rhPON2 reduced macrophage lipid peroxides and inhibited cell-mediated LDL oxidation in these cells compared to non-transfected control cells. A non-glycosylated rhPON2 was produced in *Escherichia. coli* cells and demonstrated to hydrolyse bacterial 3-oxo-C_{12}-HSL, and reduced *P. aeruginosa* biofilm formation by 50% (146). In addition, these authors demonstrated that the stability of the non-glycosylated rhPON2 could be improved by the addition of trehalose (protein stabiliser) to the storage buffer (146). Draganov and colleagues (2005) (131) produced rhPON2 in insect cells (131), and showed that the purified protein was naturally glycosylated in these cells and was stable and active against bacterial 3-oxo-C_{12}-HSL *in vitro*. In general, glycosylation seems important for protein stabilisation, and extracellularly produced proteins are apparently protected from proteolytic degradation, oxidation and denaturation (147).

In the present study, a glycosylated form of rhPON2 was produced in insect cells and investigated for its ability to hydrolyse the lactone ring of 3-oxo-C_{12}-HSL and reduce biofilm formation by stationary-phase *P. aeruginosa*.

2.2 Material and methods

2.2.1 Generation of baculovirus stocks for rhPON2 production and purification

2.2.2 Insect cell culture

Spodoptera frugiperda (Sf9) cells (Life Technologies (batch 906942), Carlsbad, CA) were used to produce baculoviruses. Cells were seeded in 250 mL flat-bottom polycarbonate Erlenmeyer shaker flasks with vented polypropylene caps (Corning, Corning, NY) at 5 x 10^5 cells/ ml in Sf-900-III growth media (Life Technologies, Carlsbad, CA) supplemented with 500 units/mL penicillin (Life Technologies, Carlsbad, CA) and 500 μg/mL streptomycin (Life

Technologies, Carlsbad, CA). Flask were incubated at 28 °C, up until the cells reached a density of 3 x 10^6 cells/ml (usually after ~ three days of incubation).

High Five™ cells (Life Technologies, Carlsbad, CA) were used for rhPON2 production, since protein expression is usually five-fold higher in these cells compare to Sf9 cells (131, 148). The naturally adherent High Five™ cells were grown in T-25 tissue culture flasks containing Express Five™ medium supplemented with 10 μg/mL gentamycin (Sigma, St Louis, Missouri) and 20 mM L-glutamine (Life Technologies, Carlsbad, CA). The flasks were incubated at 28 °C up until the cells reached confluency, after which time the cells were gently scraped off the base of the flask using a pipette before being reseeded at 2 x 10^4 cells/cm^2.

To maximise rhPON2 yield, High Five™ cells were first adapted to suspension growth before proceeding to protein production. A total volume of 40 ml of 7 x 10^5 High Five™ cells/ml was added to a 250 mL flat-bottom polycarbonate Erlenmeyer shaker flask. The cells were treated with 10 units/ml of porcine heparin (Sigma, St Louis, Missouri) to prevent aggregation, and the flasks were incubated at 28 °C in the dark with shaking (130 RPM). When the doubling time of the cells was between 18-24 hours and their viability was ~98%, the cells were considered adapted to suspension growth. Following adaptation, the cells were weaned off heparin over a period of two - three weeks, before being used to make rhPON2 protein.

2.2.3 rhPON2 production using the Bac-to-Bac baculovirus system

The human *PON2* gene (NCBI accession NM_000305.2, PON2 311 SNP) was previously codon optimized for expression in insect cells and cloned into the pFASTbac1 plasmid. The pFASTbac1 containing the *PON2* gene was transformed into the DH10Bac™ *E.coli* (Invitrogen, Carlsbad, CA) to generate a human PON2 bacmid (149). The human *PON2* bacmid was then transfected into Sf9 cells using the Cellfectin® reagent (Invitrogen, Carlsbad, CA) and following the manufacturer's instruction to generate a baculovirus expressing hPON2. Briefly, 8 x 10^5 Sf9 cells were transfected with 4 μg PON2 bacmid in 8 μl Cellfectin® per well in a six-well plate. Three hours later, media was replaced with 2ml of Sf-900-III media and cells incubated for four days to generate recombinant baculovirus. An endpoint dilution assay using Sf9 cells was then carried out to determine viral titres. To determine if insect cells were infected, cell monolayers were inspected for clearing, and the presence of enlarged, granulated and multi-nucleated cells was detected using a Leica DM IL microscope (400x magnification). Images were captured and acquired using a Leica DFC320 digital camera and Leica Firecam v3.4.1 software. Multiplicity of infection (MOI) and duration of infection for maximal rhPON2

production was MOI of 2.5 and three - four days, respectively (149). The *Trichoplusiani* cell line HighFive™ was infected with the baculovirus. Cell lysates were collected and the recombinant hPON2 (rhPON2) purified from the membrane fraction at Monash Protein Production Unit (Monash University, Victoria, Australia) following the three-step purification protocol as described in detail by Draganov and colleagues (2005) (131). Purified rhPON2 protein was stored in buffer E (25 mM Tris-HCl, pH 7.4, 1 mM $CaCl_2$, 10% glycerol and 0.05% *n*-dodecyl-β-D-maltoside (DDM) (Anatrace) and 200 mM methyl-α-D-mannopyranoside (Sigma, St Louis, Missouri), which was sterilised by passing through a 0.22 μm filter and then kept at 4 °C until required.

2.2.4 Preparation of buffers and stocks for 3-oxo-C_{12}-HSL hydrolysis and UPLC-MS analysis

The activity of the purified rhPON2 against 3-oxo-C_{12}-HSL was determined using ultra-performance liquid chromatography-mass spectrometry (UPLC-MS) analysis as previously described (131, 150). Buffers used included: hydrolysis reaction buffer (2.5 mM Tris-HCl, pH 7.4, 1 mM $CaCl_2$), and hydrolysis inhibition buffer (2.5 mMTris-HCl, pH 7.4, 0.5 mM EDTA). Buffers were sterilised by passing through a 0.22 μm filter. Solvents for UPLC-MS were solvent A (1% acetic acid) and Solvent B (100% acetonitrile) (Sigma, St Louis, Missouri).

Standard curves were prepared using a mixtures of 3-oxo-C_{12}-HSL (closed lactone ring) and 3-oxo-C_{12}-HSL acid (open lactone ring) as described by Teiber and Draganov (2011) (150). Stocks of 3-oxo-C_{12}-HSL (Cayman Chemicals, MI, USA) were prepared by dissolving in acetonitrile to a concentration of 10 mM. Next, the 3-oxo-C_{12}-HSL acid form was generated by treating 100 μM of 3-oxo-C_{12}-HSL stock with 1 mM NaOH at room temperature for a minimum of 30 minutes. The hydrolysis reaction was stopped by adding an equal volume of HPLC grade acetonitrile containing 1 mM HCl to neutralise the reaction (final concentration of 3-oxo-C_{12}-HSL-acid in each reaction was 50 μM). The unmodified 3-oxo-C_{12}-HSL was similarly diluted with an equal volume of HPLC grade acetonitrile containing 1 mM HCl to 50 μM. Finally, an equal volume of the lactone form was added to the acid form producing a stock solution containing 25 μM each of 3-oxo-C_{12}-HSL lactone and 3-oxo-C_{12}-HSL acid. This stock was diluted in 50% acetonitrile (in degassed distilled H_2O) to the following concentrations, 5 μM, 2.5 μM, 1.25 μM, 635 nM. 312.5 nM, 104 nM and 52 nM. Ten microlitre samples were injected into the UPLC for separation and MS analysis.

2.2.5 Determination of rhPON2 lactonase activity using UPLC-MS analysis of 3-oxo-C_{12}-HSL hydrolysis

The lactonase activity of rhPON2 was determined within a specific time *in vitro* by exposing the enzyme to 3-oxo-C_{12}-HSL, as described by Teiber and Draganov (2011) (150). Briefly, 5 µl of either buffer E or rhPON2 were added to 94 µl of either hydrolysis reaction buffer or inhibition buffer (containing chelator EDTA, inhibiting activity of the Ca^{2+}-dependent PON2). Then, 1 µl of 5 mM 3-oxo-C_{12}-HSL was added as required and the tubes were kept in a 37 °C water bath for varying time periods. Reactions were stopped by the addition of 100 µl of ice cold acetonitrile and immediately kept on ice for two minutes prior to centrifugation for two minutes at 14,000 g. Supernatants were transferred to clean eppendorf tubes and kept at -80 °C until required.

The proportions of 3-oxo-C_{12}-HSL lactone and acid forms in each reaction were determined by UPLC–MS according to published methods (151), using a Waters Acquity H-series UPLC BEH C18 column (2.1 × 100 mm × 1.7 µ particles) coupled to a Waters Xevo triple quadrupole mass spectrometer (UTAS Central Science Laboratory, Hobart, Tasmania). Solvents used were 1% acetic acid (Solvent A) and 100% acetonitrile (Solvent B) and a gradient from 50% A:50% B to 10% A: 90% B over four minutes, followed by immediate column re-equilibration to starting conditions for three minutes before addition of the next sample. The flow rate was 0.35 ml per minute, column temperature 35 °C, injection volume 10 µl and a typical retention time for 3-oxo-C_{12}-HSL under these conditions was 2.85 minutes. The mass spectrometer was operated in positive ion electrospray mode with a needle voltage of 3 kV, and a multiple reaction monitoring (MRM) mode was used to detect and quantify the analytes. Ion source temperature was 130 °C, desolvation gas was nitrogen at 950 litres per hour, cone gas flow was 100 h and the desolvation temperature 450 °C. Data was collected and processed using MassLynx software. The MRM channels for 3-oxo-C_{12}-HSL were *m*/*z* 298.2–95.0, *m*/*z* 298.2–102.0, and *m*/*z* 298.2–197.1 with a cone voltage of 30 V and collision energy 20 V for all channels. Dwell time was 50 ms per channel. Calibration was against an external standard calibration mixture of the analyte at seven different concentrations ranging from 53 nM to 5 µM (150). Second order polynomial correlation coefficients were typically 0.9998 or higher in all cases. Samples were bracketed by full standard curves run after every sample, and a single QC calibration point (625 nM) was also acquired in the middle of each sample. Finally, quantification was carried out using the sum of the three MRM channels (151).

2.2.6 rhPON2 activity calculation

The lactonase activity of rhPON2 was calculated as nmoles of 3-oxo-C_{12}-HSL hydrolysed in 1 minute/mg of protein (as determined by the EZQ protein quantification kit (Thermofisher Scientific, Waltham, MA) based on previously described methods (149). The percentage hydrolysis for each sample was calculated as follows:

$$\frac{\text{3-oxo-}C_{12}\text{-HSL acid}}{\text{3-oxo-}C_{12}\text{-HSL acid+3-oxo-}C_{12}\text{-HSL}} \times 100$$

2.3 Quantification of bacterial biofilms using a crystal violet staining assay

Biofilm quantification was performed using the standard crystal violet staining assay as described previously (152) with the following modifications. Briefly, an overnight (stationary-phase) culture of *P. aeruginosa* (strain PAO1, ATCC 15692), was diluted into fresh LB broth to achieve a final inoculum of ∼1×10^6 CFUml^{-1} and 200 µl aliquots treated with either buffer E or 5U rhPON2 in sterile clear flat-bottomed 96-well polystyrene microtiter plates (microplate, Greiner Bio-One, Cat. No. 655180) for 24 hours and incubated at 37 °C without shaking. LB medium containing planktonic (non-adherent) bacterial cells was removed from each well and the remaining adherent (biofilm) cells gently washed three times with 200 µl of 0.85% (w/v) sodium chloride. The biofilms were subsequently stained with 200 µl of a 0.1% (w/v) crystal violet (Sigma–Aldrich, Cat. No. C3886, St Louis, Missouri) solution prepared in sterile MilliQ water, for 20 minutes at room temperature. Excess crystal violet was removed from the well by gently rinsing the wells three times with sterile 0.85% (w/v) sodium chloride, and the microplate was allowed to air-dry at room temperature for ∼20–30 minutes. Then 200 µl of 30% (v/v) acetic acid (Sigma–Aldrich, Cat. No. 6283, St Louis, Missouri) was added to each well and mixed by pipetting, to extract the crystal violet from the biofilms. Biofilm formation was determined from 14 replicate samples by measuring the absorbance (A_{500} nm) of the extracted crystal violet in a spectramax M^2 microplate spectrophotometer (Molecular Devices, CA, USA). A Student's two-tailed t-test was used to determine differences between groups and a *P* value of ≤0.05 was assessed as significant.

2.4 Fluorescent staining to visualise bacterial biofilms

An overnight (stationary-phase) culture of *P. aeruginosa* (PAO1), was diluted in fresh LB broth to achieve a final inoculum of ∼1×10^6 CFUml^{-1} and 1 ml aliquots treated with either buffer E or 5U rhPON2. Aliquots were pipetted onto sterile (22 × 25 mm) glass cover slips (Ramsay

Surgical Limited Scientific Division, Australia) and cultures incubated for 24 hours at 37 °C without shaking. LB medium and planktonic (non-adherent) bacterial cells were removed and attached (biofilm) cells were gently washed three times with 200 µl of 0.85% (w/v) sodium chloride. The biofilms were stained with Live/Dead *Bac* Light probes for 30 minutes in the dark according to the manufacturer's instructions (Molecular Probes, OR, USA). The Live/Dead *Bac* Light staining kit consists of two dyes: membrane-permeant SYTO9 that stains live bacteria with green fluorescence; and membrane–impermeant propidium iodide that stains membrane-compromised (dead) bacteria with red fluorescence. After staining, biofilms were fixed with 4% paraformaldehyde for 20 minutes at room temperature, washed three times with 0.85% (w/v) sodium chloride for 5 minutes each and mounted onto slides with Dako fluorescent mounting media (Dako, Denmark). Biofilms were examined by fluorescent microscopy using an Olympus BTX50 microscope at 200 x magnification and images captured using a Cool Snap HQ2 digital camera (Photometrics, AR, USA) and NIS-Elements software V4.16.

2.5 Real-time quantitative PCR (RT-PCR)

An overnight (stationary-phase) culture of *P. aeruginosa* (PAO1), was diluted in fresh LB broth to achieve a final inoculum of $\sim 1\times10^6$ CFU/ml and 1 ml aliquots treated with either buffer E or 5U rhPON2 and incubated for 1 hour with shaking (150 rpm) at 37 °C. Total RNA was isolated using the SV total RNA isolation kit (Promega, Madison Wisconsin), following the manufacturer's instructions.

2.6 cDNA synthesis and Quantitative RT-PCR

The Transcriptor First Strand cDNA synthesis (Roche, Mannheim, Germany) was used to reverse transcribe RNA to cDNA according to the manufacturer's instructions using both random hexamer and anchored oligo $d(T)_{18}$ primers. One µg of RNA was reverse transcribed to cDNA. and diluted 1 in 5 in nuclease free water and kept at -20 °C until required.

Quantitative RT-PCR was performed using a LightCycler 480 Real-Time PCR System (Roche, Basel, Switzerland) and SYBR Green detection (Roche, Basel, Switzerland). Primers used for qPCRs are listed in Table 2.1. Each qPCR contained 10 ng cDNA and a final primer concentration of 1 nM. PCR conditions were as follows: 95 °C for 5 minutes, then 40 cycles of 95 °C for 10 seconds, 60 °C for 10 seconds and 72 °C for 30 seconds. All PCR products underwent melt curve analysis and the expression level of each gene relative to the 16S rRNA gene [*psd7* primer pair (153)] was calculated using the $2^{-\Delta\Delta Ct}$ method (154).

Table 2.1. List of primers for amplification of *P. aeruginosa* genes

Target gene	Forward primer (5'-3')	Reverse primer (5'-3')	Reference
lasR	ccctgtggatgctcaaggactac	gcttccgagcagttgcagataac	(149)
lasI	caagtgttcaaggagcgc	gccagcaaccgaaaacc	(149)
16S rRNA	caaaactactgagctagagtacg	taagatctcaaggatcccaacggct	(153)

2.7 Results

2.7.1 Production of rhPON2 using the Bac-to-Bac baculovirus system (Invitrogen)

2.7.2 pFASTBac1 bacmid contains the cloned huPON2 gene

The pFASTbac1 containing the *PON2* gene was transformed into the DH10Bac^{TM} *E.coli* to generate a recombinant human PON2 bacmid (149). The pUC/M13 primers were to used amplify the area containing the hPON2 insert and a product of the expected size of 3,400 bp (2,300 bp of plasmid nucleotide sequence plus 1,095 bp of hPON2 nucleotide sequence) was generated (Figure 2.1a). This confirmed the presence of the hPON2 gene in the bacmid.

2.7.3 Expression of rhPON2 by Sf9 insect cells

To generate a h*PON2* expressing baculovirus, the hPON2 bacmid was transfected into Sf9 insect cells that lacked a *PON* gene homolog using cellfectin® (consisting of a cationic lipid formulation). Microscopic evaluation of hPON2 bacmid transfected Sf9 cells showed that three days after infection, cells were multi-nucleated and enlarged (Figure 2.1c) compared to non-transfected Sf9 cells (Figure 2.1 b). Both Sf9 not-transfected and hPON2 bacmid transfected Sf9 cells were lysed with 1%NP40 and the expression of rhPON2 confirmed in transfected cells by dot blot analysis using a PON2 specific antibody (Figure 2.1d). Collectively, these results suggest that the Sf9 cells were transfected with hPON2 therefore should secrete hPON2 baculovirus. Supernatant from the hPON2 bacmid Sf9 transfected cells was collected, clarified, and filtered, and the baculoviruses stored at 4 °C. To increase viral titre, a second round of baculovirus amplification in Sf9 cells was undertaken, and supernatants were collected three days post infection. Baculovirus loads were then determined using an endpoint dilution assay (Invitrogen). Briefly, baculovirus containing supernatants were serially diluted to 10^{-9} in media, and each dilution was added to an aliquot of Sf9 cells, and the mixture was incubated for two days before being visualised by microscopy. Virus titres were determined to be between 10^{7}

and 10^8 plaque forming units/ml (Figure 2.2), since few multi-nucleated and enlarged cells were obtained when using the 10^{-9} dilution (baculovirus) supernatant. Baculovirus stocks were clarified by centrifugation, filtered through a 0.22 μM filter, and kept at 4 °C until required.

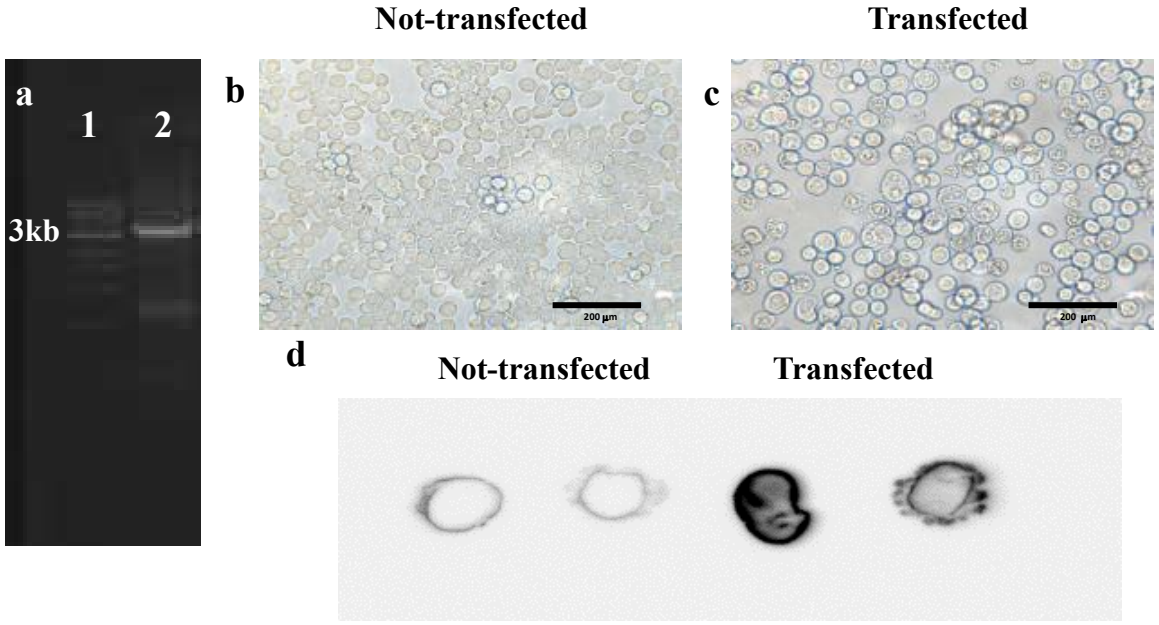


Figure 2.1. Production of baculovirus containing hPON2.

a) The cloned h*PON2* gene was amplified from the pFast Bac vector using pUC and M13 primers and a product of the expected size (lane 2, 3400 bp fragment) was observed by agarose gel electrophoresis (lane 2). Molecular weight ladder. (lane 1). The thicker DNA band represents 3000bp Visualisation of non-transfected (b) and hPON2 bacmid transfected (c) Sf9 insect cells at 400x magnification. Transfected cells appeared to be enlarged and multi-nucleated compared to control. d) Dot blot analysis of lysed non-transfected and hPON2 bacmid transfected Sf9 cells using a PON2 specific antibody.

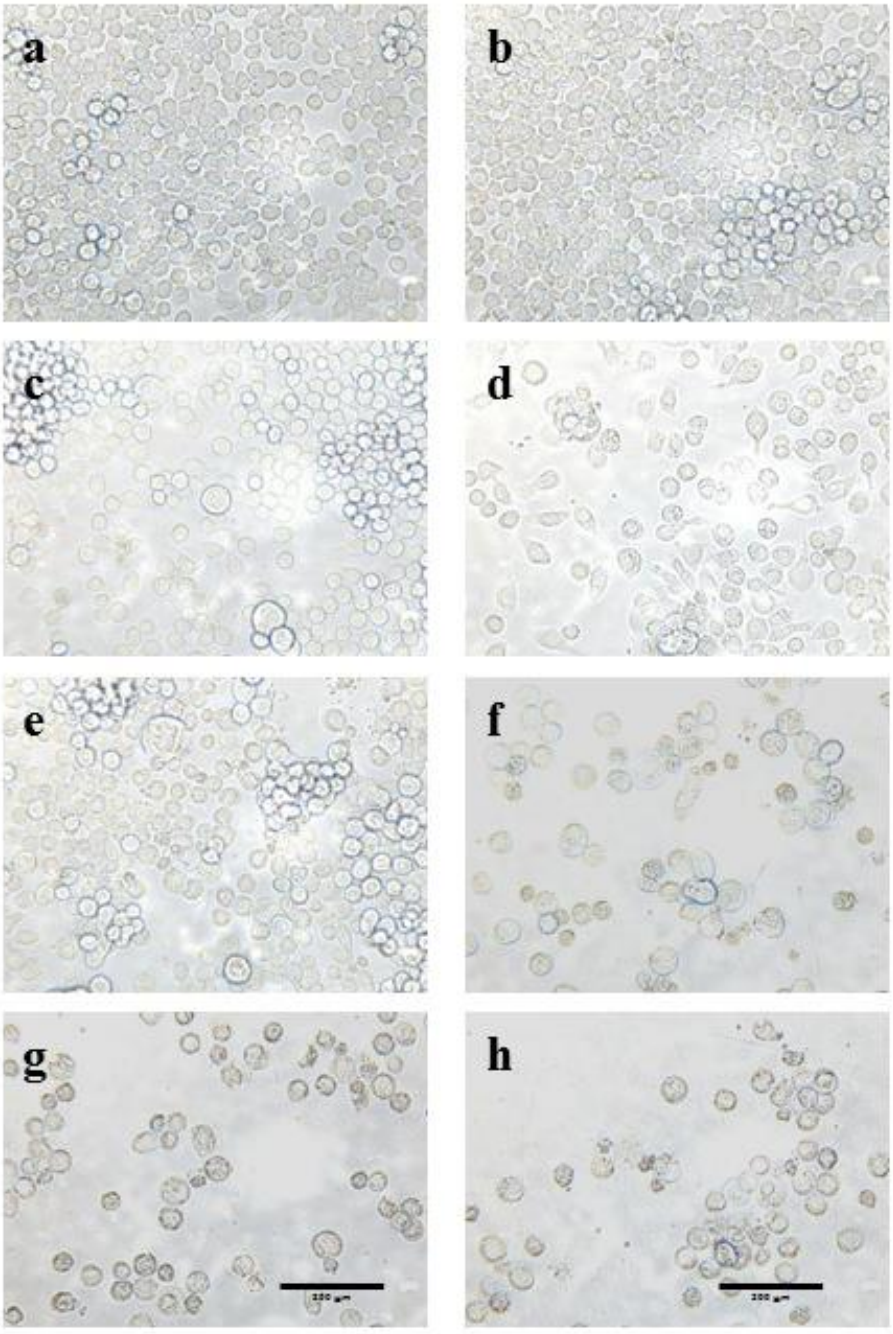


Figure 2.2. Endpoint dilution assay to determine rhPON2 baculovirus titre.

Sf9 cells were not-infected (a), or infected with diluted (b) 10^9, (c) 10^8, (d) 10^7, (e) 10^6, (f) 10^5, (g) 10^4 and (d) 10^3 baculovirus and incubated for two days before examination under light microscopy (400 x magnification) to determine the end point dilution (Scale bar 200 μm).

2.7.4 Infection of HighFive™ cells to produce rhPON2

Following adaption to suspension culture, HighFive™ insect cells were infected with 2.5 MOI baculovirus containing the h*PON2* gene to produce rhPON2. After two days of infection, the infected HighFive™ cells were enlarged and multi-nucleated compared to not-infected cells (Figure 2.3a). Not-infected and baculovirus infected cells were lysed with 1% NP-40 and production of rhPON2 assessed by dot blot analysis using a PON2 specific antibody. Cells infected with the hPON2 baculovirus produced the rhPON2 protein (Figure 2.3b). Multiple batches of hPON2 baculovirus infected HighFive™ cells were prepared, and cell lysates kept at -80 °C until protein purification.

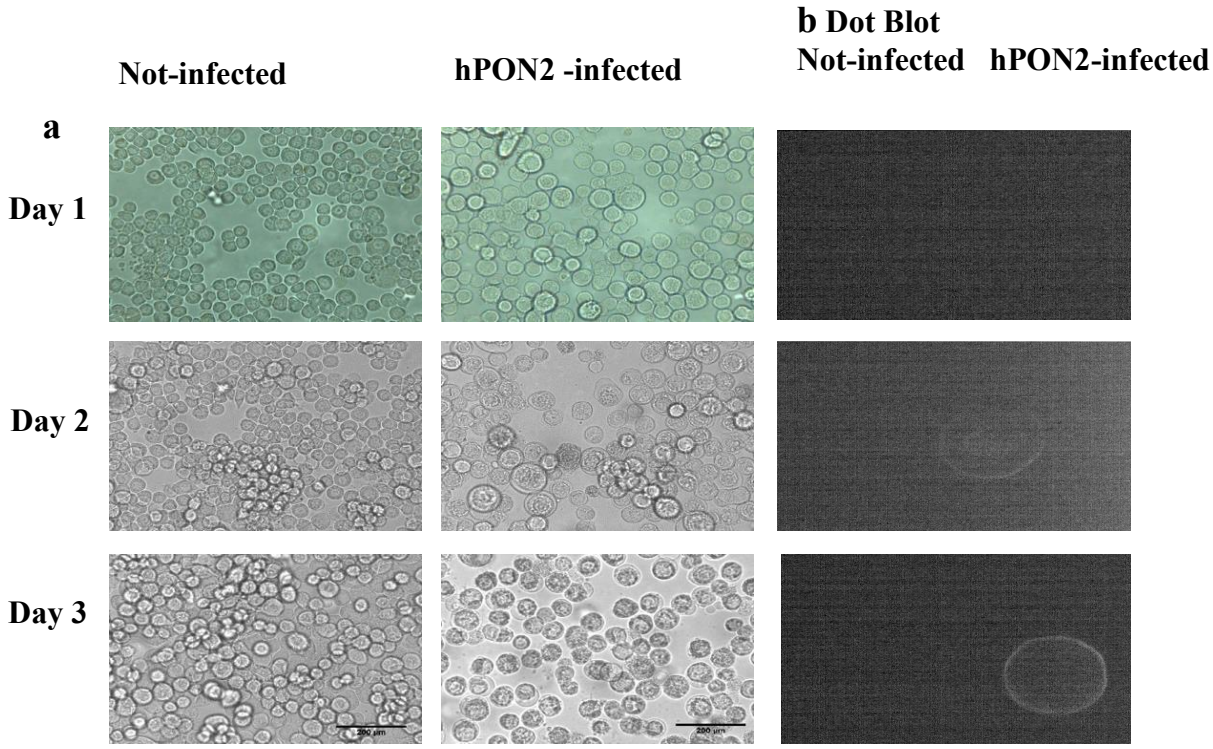


Figure 2.3. Production of rhPON2 from HighFive™ insect cells.

a) HighFive™ insect cells were infected with 2.5 MOI baculovirus expressing rhPON2 for 1, 2 and 3 days. Cells were examined using light microscopy at 400 x magnification (Scale bar 200 μm) to determine baculovirus infectivity assessed by the appearance of enlarged and multi-nucleated cells in response to infection (b). Non-infected and baculovirus PON2 infected HighFive™ insect cells were lysed on days one, two and three. The production of rhPON2 protein was assessed by dot blot analysis using a PON2 specific antibody.

2.7.5 Large-scale rhPON2 protein purification

Large-scale protein purification of rhPON2 from baculovirus infected HighFive™ insect cells was undertaken using the two-step liquid chromatography method described by Draganov *et al.* (131) at the Monash Protein Production Unit (Monash University, Victoria, Australia). Membrane proteins isolated from hPON2 infected HighFive™ cells were separated using DEAE anion chromatography. The rhPON2 eluted as a broad peak with 100 - 300 mM NaCl (Figure 2.4a). Suitably collected fractions were analysed by SDS-PAGE and stained with Coomassie. A doublet protein band at the expected size (~40 kDa, glycosylated rhPON2) was observed (Figure 2.4c). Fractions collected from the shoulder of the first eluted peak (see Figure 2.4 b) had the most intense staining for this protein and contained the least amount of contaminating proteins; in turn, fractions B2 to C4 were pooled for further rounds of purification by concanavalin A (con A) affinity chromatography. Glycosylated proteins, including rhPON2, usually bind to concavalin A columns, and this binding can be disrupted by incorporation of a mannopyranoside sugar in the elution buffer (131). Analysis of con A fractions by SDS-PAGE showed that fractions two to ten contained glycosylated rhPON2 (two bands at the expected size of ~40kDa, Figure 2.5 a) and that a contaminating protein of ~ 25 kDa was present in all fractions. Fractions two to ten were subsequently pooled and the presence of glycosylated rhPON2 confirmed by immunoblotting using a human PON2 specific antibody (Figure 2.5b).

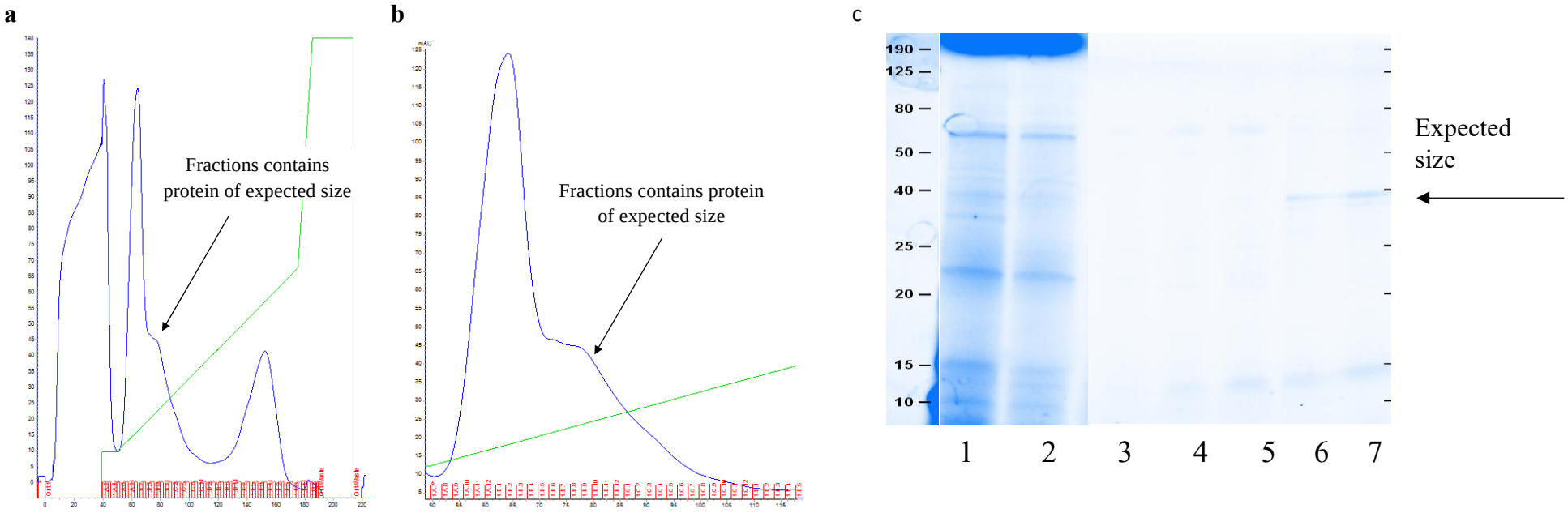


Figure 2.4. Purification of rhPON2 from the membrane fraction of infected insect cells using DEAE chromatography.

The elution profile of proteins (based on A_{280} nm) from the membrane fraction of rhPON2 baculovirus infected HighFive™ cells using DEAE chromatography (a) and magnified profile (b). SDS-PAGE analysis of DEAE fractions (c): Lane 1: total membrane protein loaded onto DEAE column; Lane 2: supernatant from lysed HighFive ™ infected cells; Lanes 3-7: DEAE fractions A11, B1, B3, B7, and B9, respectively.

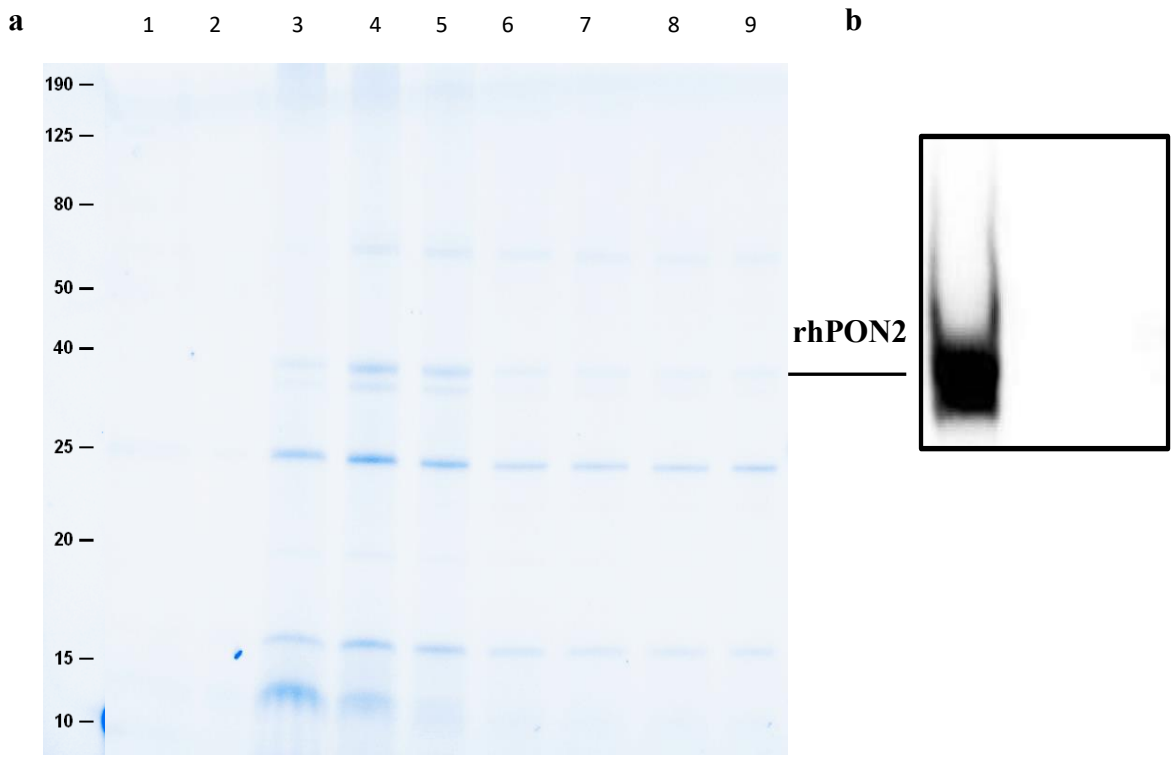


Figure 2.5. Purification of rhPON2 using Con A chromatography.

Pooled fractions from the DEAE chromatography step were mixed with Con A resin overnight by rotation at 4 °C. The resin was collected in a column, washed, and the protein was eluted as previously described (131). Fractions were analysed by SDS-PAGE under reducing conditions. Lane 1 fraction containing non-binding proteins; Lane 2: column wash: Lanes 3 – 9: DEAE elution fractions 2, 3, 4, 5, 6, 8, and 9, respectively.

2.7.6 rhPON2 hydrolyses 3-oxo-C_{12}-HSL

To determine the hydrolytic activity of the purified rhPON2 against 3-oxo-C_{12}-HSL, duplicate reactions were setup with and without an enzyme co-factor (1 mM Ca^{2+}) and an inhibitor (1 mM EDTA), as previously described (150). The concentration of 3-oxo-C_{12}-HSL-lactone (non-hydrolysed) and 3-oxo-C_{12}-HSL-acid (hydrolysed) was determined in each reaction using UPLC-MS analysis against a standard curve. The purified rhPON2 hydrolysed 95% of the lactone ring of 100 μM 3-oxo-C_{12}-HSL within two minutes at 37 °C. The activity was specific to rhPON2, since no hydrolysis occurred in the presence of 1 mM EDTA (inhibitor), or in buffer E alone without the enzyme co-factor (Figure 2.6a). The activity of the purified rhPON2 was calculated to be 6862.5 units/mg of protein (Table 2.2).

In order to assess the stability of rhPON2 to inform storage and treatment options, aliquots of rhPON2 were incubated at different temperatures, and the change in hydrolytic activity assessed as described above. An aliquot of rhPON2 was frozen at -80 °C for one week, thawed quickly, and the lactonase activity assessed before and after incubation at 37 °C for three days. The results demonstrated that freeze-thawing followed by incubation at 37 °C did not significantly affect rhPON2's enzyme activity (Figure 2.6b).

In addition, a time course was conducted to determine the hydrolytic activity of rhPON2 against 3-oxo-C_{12}-HSL over three days at 37 °C. Between three and six hours at 37 °C, less than 20% decrease in enzymatic activity against 100 μM of 3-oxo-C_{12}-HSL was determined. The hydrolytic activity remained stable for up to three days (Fig. 2.6c), which suggested that the rhPON2 retained its stability at 37 °C.

Table 2.2. Calculation of rhPON2 specific activity against 100 μM 3-oxo-C_{12}-HSL.

1098	nM acid produced in two minutes (in diluted sample)
54900	nM acid produced in original 100 μl reaction (equals nmoles lactone
5.49E-09	moles AHL hydrolysed in two minutes
2.75E-09	moles AHL hydrolysed/minute
2.75E+00	nmoles AHL hydrolysed/minute
2.75	Units in 5 μl of PON2
0.08	Mg/ml protein concentration
2.75	Units/5 μl of protein
0.0004	Amount of protein (mg) in 5 μl
6862.50	Specific activity

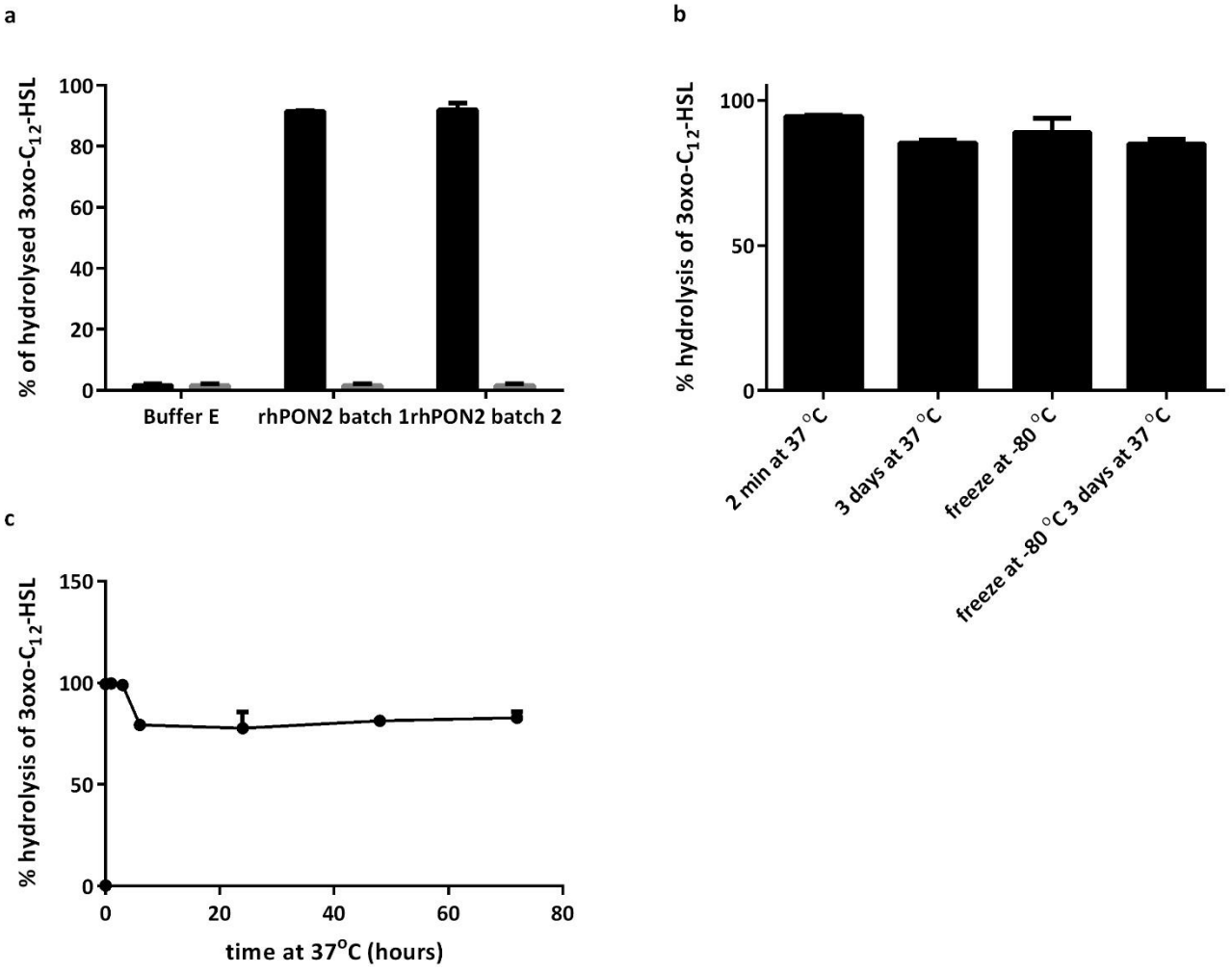


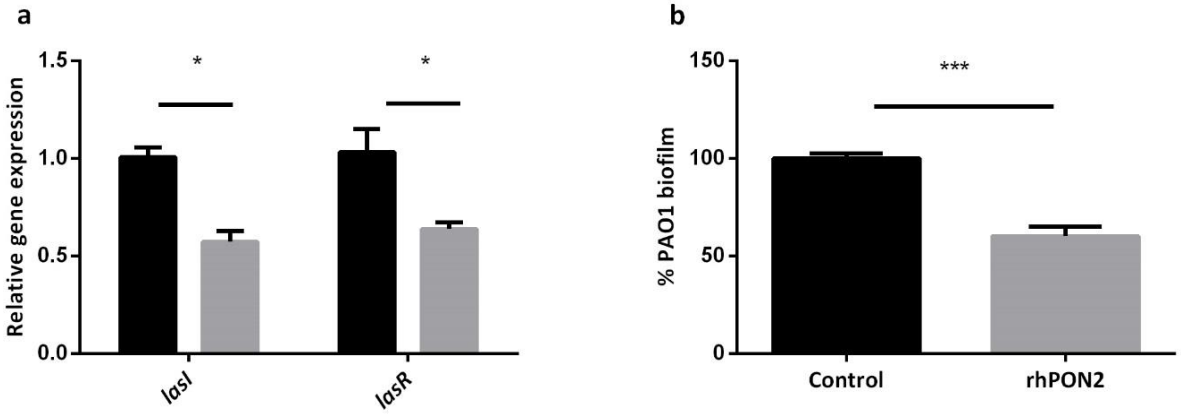
Figure 2.6. rhPON2 activity against 3-oxo-C_{12}-HSL.

Enzyme activity of purified rhPON2 was assessed by UPLC-MS. (a) % hydrolysis of 3-oxo-C_{12}-HSL to 3-oxo-C_{12}-HSL acid by rhPON2 in the presence of 1 mM Ca^{2+} (activator, black bars) or 1mM EDTA (inhibitor, grey bars). (b) Activity change following freezing for one week at -80 °C, thawing and incubation at 37 °C for three days, or a combination of these treatments. c) Activity of rhPON2 after incubation at 37 °C for 0 - 72 hours. Results represent mean % hydrolysis of 3-oxo-C_{12}-HSL ± SEM of n = 3.

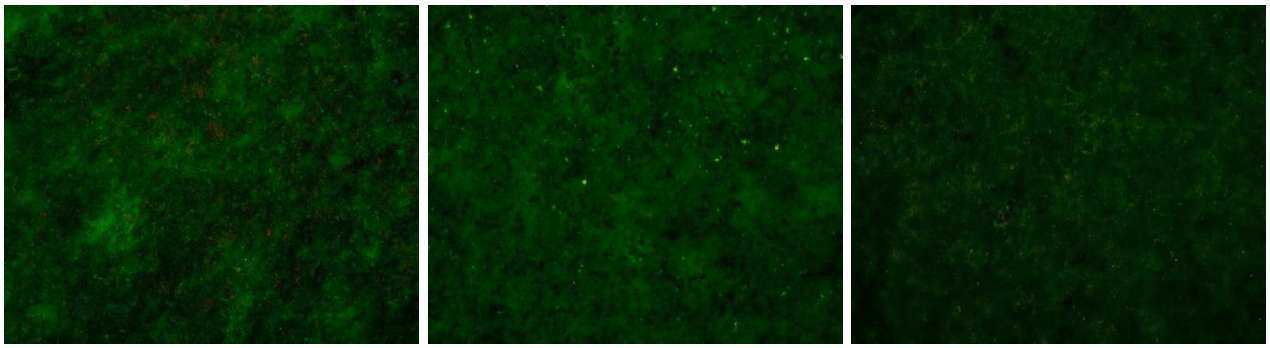
2.8 rhPON2 treatment of *P. aeruginosa* reduces expression of QS-associated genes and bacterial biofilm formation

To determine whether rhPON2 could reduce the expression of key *P. aeruginosa* QS-related genes mid-exponential-phase cultures of *P. aeruginosa* (PAO1) were treated with buffer E (control) or 5 U rhPON2 for 1 hour, after which time the expression of the quorum sensing synthase *(lasI)* and regulator (*lasR)* genes were assessed by RT-qPCR. Expression of both *lasI*

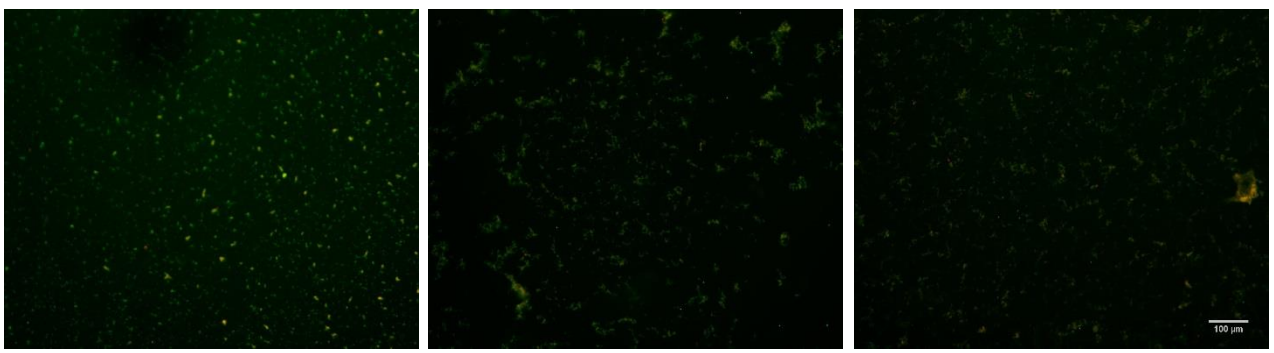
and *lasR* was significantly decreased (Figure 2.7a) in cells treated with rhPON2 compared to buffer-treated control cells. Treating stationary-phase cultures with 5 U rhPON2 for 24 hours also significantly reduced biofilm formation by this organism, as revealed by the crystal violet (Figure 2.7b) and coverslip bacterial biofilm assays (Figure 2.7c). The results of the coverslip bioassay using the live dead straining also demonstrated, as expected, that rhPON2 was reducing biofilm formation by *P. aeruginosa* without killing the bacterial cells.



C Biofilm formation after PAO1 was treated with vehicle control (buffer E) for 24 hours



Biofilm formation after PAO1 was treated with 5U rhPON2 for 24 hours



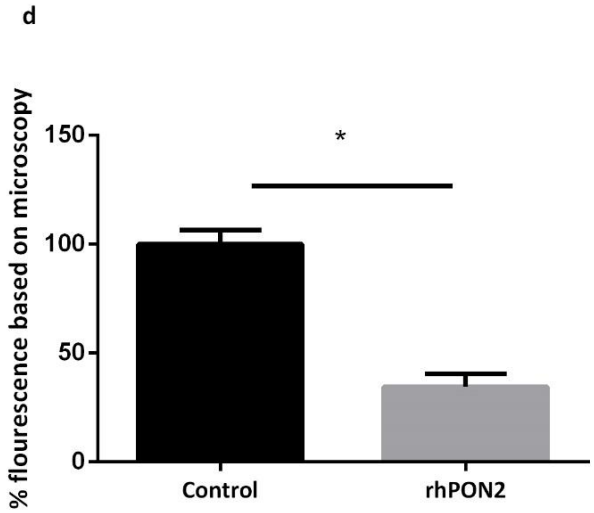


Figure 2.7. rhPON2 reduces biofilm formation and expression of key QS genes.
(a) Mid-exponential *P. aeruginosa* PAO1 cells were treated with 5U rhPON2 (grey bars) or vehicle control Buffer E (black bars) for 1 hour later and the expression of *lasI* and *lasR* genes was assessed by RT-qPCR relative to the 16S rRNA gene. Mid exponential cells were treated with or without 5U rhPON2 for 24 hours and biofilm formation was measured using the (b) crystal violet microtiter plate biofilm assay and (c) and a biofilm coverslip assay using the Live/Dead BacLight stain (Green SYTO9 stain indicates live cells, whereas red propidium iodide stain indicates dead cells). After staining, biofilms were fixed and visualised using fluorescence microscopy. Scale bar = 100 μm. (d) Fluorescence intensity from coverslip biofilm images was measured by Image J. Results represent mean ± SEM of $n = 3$. Differences between groups assessed using Student's two-tailed t-test; *$P \leq 0.05$, ** $P \leq 0.01$

2.9 Discussion

Active recombinant human PON2 was produced using the method of Draganov and colleagues (2005) (131). The final rhPON2 containing protein fraction had one major contaminating protein (~25 kDa in size), similar to that reported by Draganov *et al.* (2005) (131). Previous works in our laboratory demonstrated that the contaminating protein likely originated from the *Trichoplusiani* insect cells, since cell lysates harvested from non-infected cells and the purified proteins (by the same method as for infected cells) resulted in the equivalent fractions containing the contaminating protein. Additionally, these lysates did not have any lactonase activity against 3-oxo-C_{12}-HSL as demonstrated by UPLC-MS (149).

In the present study, purified rhPON2 catalysed almost 100% hydrolysis of the 3-oxo-C_{12}-HSL-lactone in the presence of 1 mM Ca^{2+} but not in the presence of 1 mM EDTA (inhibitor).

These results are consistent with PON2 being a calcium-dependent lactonase (131, 150). The activity of the purified rhPON2 was calculated as 6862.5 units/mg, which was similar to the activity reported for previous purified rhPON2 preparations (131, 136). The purified rhPON2 was glycosylated as demonstrated by the double band at the correct size (39-42kDa), which is also consistent with Draganov and colleagues (131). It is anticipated that the rhPON2 produced in the present study was glycosylated with high-mannose type sugars as previously reported by Draganov and colleagues (131), which is thought to improve protein stability by protecting proteins from degradation by proteolytic enzymes, oxidation, and pH-mediated denaturation (147). The hydrolytic activity of rhPON2 (Figure 2.6c) was retained even after the protein was kept at 37 °C for three days. In this context, the only major loss in lactonase activity (~20%) seemed to occur in the first six hours of incubation, but thereafter the lactonase activity remained stable. The activity of rhPON2 was also not significantly affected by a cycle of freeze-thawing prior to incubation at 37 °C for three days (Figure 2.6b). Remarkably, purified rhPON2 was shown to be active after six months of storage at 4 °C by Draganov and colleagues (2005) using a similar purification strategy. Together, the results presented in this study and those of other similar studies, suggest that purified rhPON2 had good stability, which might be important for its potential as a therapeutic.

In this chapter, the bacterial response to rhPON2 was also investigated. The results clearly demonstrated that treatment of *P. aeruginosa* with rhPON2 for 24 hours reduced biofilm formation by this organism by 50% as assessed using the biofilm coverslip and crystal violet assays. These results are consistent with previously published data showing that rPON2 produced in *E. coli* reduced biofilm formation by *P. aeruginosa* (146). Similarly, Ma and colleagues (2009) (155) demonstrated that *P. aeruginosa* engineered to overproduce either hPON1, hPON2, or hPON3 had reduced biofilm formation compared to otherwise wild-type bacterial cells, and that biofilm formation could be prevented by treating bacterial cells with a polyclonal anti-hPON antibody. Furthermore, the live dead staining of the *P. aeruginosa* biofilms showed that rhPON2 inhibited biofilm formation without reducing the viability of the bacterial cells. These results are consistent with previous studies in our laboratory that demonstrated that rhPON2 did not affect the growth of *P. aeruginosa* (149).

Additionally, the present study shows for the first time that rhPON2 treatment of bacterial cells reduced the expression of the quorum sensing regulator genes (*lasI* and *lasR*). Accordingly, previous study performed in our laboratory showed that rhPON2 significantly reduced the amounts of 3-oxo-C_{12}-HSL in stationary-phase cultures of *P. aeruginosa* (149).

In summary, the work presented in this chapter has demonstrated that rhPON2 produced from insect cells was active and reasonably stable. More importantly perhaps for present purposes, the addition of rhPON2 to *P. aeruginosa* cells reduced the expression of at least two of its QS genes, *lasI* and *lasR*, and diminished its ability to form mature biofilms.

Chapter Three: rhPON2 treatment of airway epithelial cells protects cells from many of the 3-oxo-C_{12}-HSL-mediated damaging effects

3.1 Introduction

The bacterial quorum sensing molecule, 3-oxo-C_{12}-HSL, is involved in regulating bacterial virulence and biofilm formation. Previous work in this study has demonstrated that exogenously applied rhPON2 can hydrolyse and rapidly inactivate 3-oxo-C_{12}-HSL leading to strong inhibition of virulence gene expression and biofilm formation by *P. aeruginosa*. Additionally, the hydrolytic activity of extracellular rhPON2 was stable when the enzyme was incubated at 37 °C for up to three days, an important property for any potential use of rhPON2 as a CF therapy. Many lines of evidence have demonstrated that the bacterial 3-oxo-C_{12}-HSL also readily enters host cells and significantly and detrimentally alters mammalian gene expression on a global scale (1, 70, 71).

Bryan and colleagues (2010) treated cultured human airway epithelial cells (A549) with 50 μM 3-oxo-C_{12}-HSL for six hours and identified the differential expression of over 2,989 genes, including many pro-inflammatory genes. Additionally, these investigators identified novel pathways previously not known to be modulated in response to 3-oxo-C_{12}-HSL such as pathways involved in xenobiotic transport and metabolic processing. They showed for the first time that mammalian cells recognise 3-oxo-C_{12}-HSL as a foreign molecule and activate mechanisms that may be involved in detoxifying it (70). Mayer and colleagues (2011) (71) extended the analysis of these data using a systems biology and network analysis approach, and identified that 3-oxo-C_{12}-HSL induced over 30 different host signalling pathways; including pathways associated with cellular innate immunity and inflammation (NF-κB, TNF-α, NOD-like receptor), the MAPK- and JNK-dependent stress responses (ATF-2, NFATC1 and 2), and the calcium signalling TCR-dependent pathway. They suggested that the calcium dependent NFκB family of transcription factors *REL*, *Nκ-B2*, and *EGR1* may be involved in the upregulation of *IL-6* in airway epithelial cells (71).

In another study, Kim and colleagues (2011) (1) investigated the global transcriptional response of human aortic endothelial cells (HAECs) exposed to 50 μM 3-oxo-C_{12}-HSL for four hours. Their results also showed that 3-oxo-C_{12}-HSL increased the expression of genes associated with the pro-inflammatory response, apoptosis, and MAPK signalling pathways, however, they showed for the first time that a high concentration (50 μM) of 3-oxo-C_{12}-HSL potentially

activated the unfolded protein response (UPR). A therapy that effectively targets bacterial quorum sensing should ideally therefore also be one that is capable of preventing the detrimental effects of 3-oxo-C_{12}-HSL on mammalian host cells.

To determine the potential of extracellular rhPON2 to protect cultured airway epithelial cells against the potential effects of 3-oxo-C_{12}-HSL exposure, changes in global gene expression (using RNA-seq analysis), cell morphology, apoptosis and cellular stress responses, between not-treated cells and cells exposed to 3-oxo-C_{12}-HSL alone, rhPON2+3-oxo-C_{12}-HSL, or rhPON2 alone was investigated.

3.2 Materials and Methods

3.2.1 Reagents and Antibodies

3-oxo-C_{12}-HSL was purchased from Cayman (Ann Abor, Michigan) and a 50 μM stock was prepared in 0.1% dimethyl sulfoxide (DMSO) and stored at -20 °C until required. Antibodies used were: PON2 (C5) (Santa Cruz, CA); goat anti-mouse biotin (AbD Serotech, Raleigh, NC); and streptavidin-HRP (AbD Serotech). Immunoblots were developed using the Immobilon Western Chemiluminescent HRP substrate (Millipore, Billerica, MA).

Buffer E was used for solubilisation of rhPON2 (131). Buffer E contained 25 mM Tris-HCl, pH 7.4, 1 mM $CaCl_2$, 10% glycerol, 0.05% *n*-dodecyl-β-D-maltoside (DDM) (Anatrace), and 200 mM methyl-α-D-mannopyranoside (Sigma, St Louis, Missouri).

3.2.2 Mammalian Cell culture

The respiratory cell line NuLi-1 (non–CF, ATCC CRL-4011) (156) was purchased from ATCC and cultured in serum free bronchial epithelial cell growth medium (BEGM, from Lonza, Walkersville, MD), supplemented with growth factors and cytokines, as well as 500 U/mL penicillin and 500 μg/mL streptomycin (Life Technologies, Carlsbad, CA). All culture flasks/plates were coated with 60 μg/mL human placental collagen Type IV (Sigma) prepared in DPBS (Life Technologies) according to ATCC guidelines.

3.2.3 Pre-treatment of mammalian cells with rhPON2 with and without 3-oxo-C_{12}-HSL for RNA-seq transcriptome analysis

NuLi-1 cells were seeded at 7 x 10^5 cells/well in collagen IV pre-coated six-well plates. Once confluent, cells were treated with vehicle control (0.1% DMSO, 1% Buffer E in BGEM media),

5 U rhPON2 (in vehicle) ten minutes prior to the addition of 50 μM 3-oxo-C_{12}-HSL (in vehicle) then incubated for two hours at 37 °C with 5% CO_2.

3.2.4 RNA extraction and cDNA synthesis

RNA was isolated from respiratory cells using Reliaprep™ (Promega, Madison Wisconsin) according to the manufacturer's instructions using the on-column DNase digestion protocol. The concentration and purity of recovered RNA was determined using a NanoDrop™ 1000 spectrophotometer (Thermo Scientific, Scoresby, VIC, Australia). RNA (1μg total) was reverse transcribed to cDNA using the Transcriptor First Strand cDNA Synthesis kit (Roche, Basel) according to the manufacturer's instructions, which involved using both anchored-oligo $(dT)_{18}$ and random hexamer primer. The cDNA was stored at -80 °C until required.

3.2.5 RT-qPCR conditions

Duplicate quantitative PCRs (qPCR) were performed on a LightCycler® 480 II system (Roche) using the LightCycler® 480 SYBR Green 1 Master Mix (Roche) according to the manufacturer's instructions. Primers (Geneworks, Thebarton SA, AUS) used in this study are listed in Table 3.1 and were designed using Primer quest (157) and checked for self-complementarity using oligo calculator (158). Each qPCR contained 10 ng cDNA and a final primer concentration of 1 nM. PCR conditions were as follows: 95 °C for 5 minutes, then 40 cycles of 95 °C for 10 seconds, 60 °C for 10 seconds, and 72 °C for 30 seconds. All PCR products underwent melt curve analysis, and the expected PCR product size was verified by agarose gel electrophoresis during the primer optimisation stage. All primer pairs were checked for reaction efficiency using triplicate serial dilutions of template cDNA with efficiency calculated as previously described (159). Gene expression relative to a reference gene (*ACTB*) was calculated using the $2^{-\Delta\Delta CT}$ method (LightCycler® Software, Roche).

Table 3.1. List of RT-qPCR primers used for human gene expression analysis

Gene	Forward primer (5'-3')	Reverse primer (5'-3')	Reference
ACTB	GGCTGGCCGGGACCTGACTGA	CTTCTCCTTAATGTCACGCACG-	(160)
IL6	TTCTCCACAAGCGCCTTCGGTCCA	AGGGCTGAGATGCCGTCGAGGATGTA	(80)
IL8	TGCTAGCCAGGATCCACAAG	GCTTCCACATGTCCTCACAAC	(149)
TNFα	GGTGCCATCAGAGGGCCTGTACC	GGGCAGCCTTGGCCCTTGAAG	(149)
JUN	CGCCCCTGTCCCCCATCG	TGTGCCACCTGTTCCCTG	This thesis
ATF3	TTGCAGAGCTAAGCAGTCGTGGTA	ATGGTTCTCTGCTGCTGGGATTCT	(80)
XBP1	CCATGGATTCTGGCGGTATTGACT	CCACATTAGCTTGGCTCTCTGTCT	(80)
ATF4	CATTCCTCGATTCCAGCAAAGCAC	TTCTCCAACATCCAATCTGTCCCG	(80)
PPARG	AGCTGAACCACCCTGAGTCC	TCATGTCTGTCTCCGTCTTCTTG	(160)
HSPA6	AAGCCTTAGGGACAAGATTCC	CCCTCTTCTGATGCTCATACTC	This thesis
hHSPA1A	GAGTCCTACGCCTTCAACAT	CTTGTCCAGCACCTTCTTCT	This thesis
hHSPA1B	GAGTCCTACGCCTTCAACAT	CGAGATGACCTCTTGACACTT	This thesis
HSPA1L	GATTACCGTGCCAGCCTATTT	CGTGGGCTCATTGATGATTCT	This thesis
DNAJ4A	GTTTATGACCAAGGCGGAGA	GTCCACCACCACCAAAGAA	This thesis
DNAJB1	GCCATGTTTGCTGAGTTCTTC	CCATAGGGAAGCCAGAGAATG	This thesis

ARC	AGTTCCTGAGCCACCTAGA	CTTGAACTCCCACCACTTCTT	This thesis
BAG3	CAAGAGTGTGGCTACAGAAGAG	CAGGATGGCTTCCACTTTCA	This thesis
MAP3K8	GCCATTCAACCAAAGCAGAC	ATGTACAGGTAGGAGGGATAGG	This thesis
NFGR	CTCCAGAACAAGACCTCATAGC	GATGGAGCAATAGACAGGGATG	This thesis
MMP3	GTGAGGACACCAGCATGAA	GACCACTGTCCTTTCTCCTAAC	This thesis
MMP10	ACCCACCTTACATACAGGATTG	GTCACCTCTTCCCAGACTTTC	This thesis
EGR1	TTTGCCAGGAGCGATGAA	GACGGGTAGGAAGAGAGAGA	This thesis
EDN1	GTTGTTCCGTATGGACTTGGA	GGCTAGCACATTGGCATCTA	This thesis
CHAC1	CCTGAAGTACCTGAATGTGCGAGA	GCAGCAAGTATTCAAGGTTGTGGC	(81)
CFTR	Quantitect Primer assay Hs_CFTR_1 SG, NM_000492, #QT00070007		Qiagen, Hilden, Germany

3.2.6 Gene expression analysis using RNA sequencing (RNA-seq) and read mapping

RNA was extracted from triplicate wells of NuLi-1 cells treated for two hours with either (i) buffer alone (vehicle controls 1% Buffer E +0.1% DMSO in BGEM), (ii) 50 μM 3-oxo-C_{12}-HSL alone, (iii) 5 U rhPON2 + 3-oxo-C_{12}-HSL, or else (iv) 5 U rhPON2 alone. The 12 RNA-seq mRNA libraries were prepared at the Ramaciotti Centre for Genomics (University of New South Wales, Australia) using the Illumina TruSeq Stranded mRNA preparation kit (Illumina details) and sequenced on the Illumina NextSeq 500 platform to produce over 30 million 75 nucleotide paired-end reads per sample. R1.fastq and R2.fastq data files were produced for each sample and these data analysed by Dr Susan Corley (Ramaciotti Centre for Genomics, UNSW, Australia).

The reads were mapped to the Ensembl *Home sapiens* genome (GRCh38). Mapping was performed with Tophat2 (v 2.0.4) (161) calling Bowtie2 (v 2.0.0-beta7) (162). HTSeq-count (Python package HTSeq, python v 2.7.3) was used to generate counts of reads uniquely mapped to annotated genes using the GRCh38 gtf file, which produced between 25M and 32M mapped reads per sample.

3.2.7 Differential gene expression (DEG) analysis

Tables of raw counts generated using HTSeq-count were used in all analyses. Comparison of gene expression was performed using the Bioconductor packages edgeR (v 3.14.0) (163) and limma (v 3.28.17) (164). Lowly expressed genes were excluded and genes with expression of at least 1 CPM (count per million) in at least three samples were tested. Counts were normalized using the trimmed mean of M-values (TMM) method and generalised linear models were used for differential expression analysis. In all cases, differentially expressed genes were defined as those genes with a Benjamini-Hochberg corrected *p* value less than 0.05. Heat maps were generated using the gplots package in R statistical program.

3.2.8 Functional analysis

GOana function (165) included in the limma Bioconductor package (v 3.28.17) (164) was used to find the most enriched gene ontology (GO) terms in the list of DEGs. The false discovery rate was set to 0.05 and the top GO function was used to order the pathways by statistical significance (166).

3.2.9 Detection of IL-6 and IL-8 cytokine secreted in culture supernatants by ELISA

NuLi-1 cells were seeded at 7 x 10^5 cells in 1 ml of media per well in collagen IV pre-coated 12-well plates and allowed to adhere overnight. The next day, cells were treated with vehicle control (0.1% DMSO, 1% Buffer E in BGEM media), 5 U rhPON2 (in vehicle) ten minutes prior to the addition of 10 or 50 μM 3-oxo-C_{12}-HSL (in vehicle) then incubated for six hours at 37 °C with 5% CO_2. Culture supernatants were collected, clarified by centrifugation, and stored at -80 °C until required. The detection of IL-6 and IL-8 was carried out using the human IL-6 and IL8/CXCL8 Duoset ELISA kits (R and D systems, Minneapolis, MN), respectively, following the manufacturer's guidelines. The IL-6 and IL-8 levels were quantified by absorbance at 450 nm using the SpectraMax M2 plate-reader (Molecular Devices, Sunnyvale, California), and their relative amounts calculated against an IL-6 or IL-8 standard curve (as per the manufacturer's instructions).

3.3.0 Cell metabolism assay

A resazurin assay was used to measure cell metabolism. NuLi-1 cells were seeded in a black 96-well plate at 1.24 x 10^4 cells per well and allowed to adhere overnight. The next day, cells were treated with vehicle control (0.1% DMSO, 1% Buffer E in BGEM media), 5 U rhPON2 (in vehicle) ten minutes prior to the addition of 50 μM 3-oxo-C_{12}-HSL (in vehicle) then incubated for two hours at 37 °C with 5% CO_2. After two hours incubation, resazurin (Sigma) was added to a final concentration of 44 μM, and the cells incubated for a further two hours before fluorescence was measured (excitation wavelength of 570 nm and emission wavelength of 590 nm) using the SpectraMax M2 plate-reader. Relative cell metabolism was calculated as percentage of the control (fluorescence reading from treated x 100 / fluorescence reading from untreated or vehicle group).

3.3.1 Apoptosis assay

The Caspase-Glo® 3/7 Reagent (Promega) was used according to the manufacturer's instructions to measure cellular apoptosis. NuLi-1 cells were seeded in white 96-well plates at 2 x 10^4 cells per well and allowed to adhere overnight. The next day, cells were treated with vehicle control (0.1% DMSO, 1% Buffer E in BGEM media), 5 U rhPON2 (in vehicle) ten minutes prior to the addition of 50 μM 3-oxo-C_{12}-HSL (in vehicle) then incubated for two hours at 37 °C with 5% CO_2. After two hours incubation, the Caspase-Glo® 3/7 Reagent (Promega, Madison Wisconsin) was added and the cells incubated for an additional 30 minutes before

luminescence was measured using the SpectraMax M2 plate-reader. Caspase 3/7 activity was based on relative light units (RLU).

3.3.2 Total Glutathione (GSH) assay

NuLi-1 cells were seeded in white 96-well plates at 2 x 10^4 cells per well and allowed to adhere overnight. The next day, cells were treated with vehicle control (0.1% DMSO, 1% Buffer E in KREBs buffer as suggested by the manufacturer), 5 U rhPON2 (in vehicle) ten minutes prior to the addition of 50 μM 3-oxo-C_{12}-HSL (in vehicle) then incubated for six hours at 37 °C with 5% CO_2. After two hours incubation, the media was removed and total GSH was determined using the GSH-glo™ (Promega) kit according to the manufacturer's instructions, and the luminescence was measured using the SpectraMax M2 plate-reader. Total GSH was calculated on a GSH standard curve.

3.3.3 Statistical analysis

All statistical analyses were performed using Graphpad Prism v4.03 (Graphpad Software, La Jolla, CA, USA). A Student's two-tailed t test was used for statistical analysis of the RNA-seq data where $p \leq 0.05$ was considered significant. The Pearson's Correlation co-efficient was used to determine the correlation between the RNA-seq and RT-qPCR fold-change, and to determine the correlation between the validated RNA-seq data from this study and the micro-array data from the study performed by Kim and colleagues (2011) (1).

3.4 Results

3.4.1 rhPON2 strongly inhibits 3-oxo-C_{12}-HSL-mediated modulation of host gene expression

The efficacy of using extracellular rhPON2 to mitigate the effects of 3-oxo-C_{12}-HSL on human respiratory cells was investigated using gene expression analysis. NuLi-1 respiratory cells were exposed to 50 μM 3-oxo-C_{12}-HSL for two hours with and without 5 U rhPON2, or with rhPON2 alone. Analysis of differentially expressed genes (DEGs) in cells treated with 3-oxo-C_{12}-HSL alone, rhPON2+3-oxo-C_{12}-HSL, or rhPON2 alone was undertaken using edgeR, and all compared to buffer treated controls. The expression of over 7,000 host genes changed in response to 3-oxo-C_{12}-HSL treatment compared to controls (edge R, FDR = 0.05). A complete list of DEGS are available in the appendix (Tables A1 - A4). Using more stringent thresholds this number was reduced to 949 genes (828 upregulated and 121 downregulated, edgeR, FDR = 1.5) compared to controls. Treatment of cells with rhPON2 strongly inhibited the gene modulatory effects of 3-oxo-C_{12}-HSL (Table. 3.2). The total number of genes for which expression was modulated was reduced from 949 to 154 when cells were exposed to rhPON2+ 3-oxo-C_{12}-HSL compared to controls, and a similar number of genes were differentially expressed when cells were treated with rhPON2 alone compared to controls (edgeR, FDR = 1.5).

Table 3.2. Comparison of number of differentially expressed host genes in each treatment group compared to controls using alternative FDRs.

Cut-off	3-oxo-C_{12}-HSL vs Control	rhPON2vs Control	rhPON2 + 3-oxo-C_{12}-HSL vs Control	rhPON2 + 3-oxo-C_{12}-HSL vs 3-oxo-C_{12}-HSL
FDR 0.05	7505	1531	2195	6078
FC 1.5	949	136	154	634

The multidimensional scaling (MDS) plot shows clustering of replicate samples and distinct separation of treatment groups, with the clearest separation evident between samples treated with 3-oxo-C_{12}-HSL compared with all other treatment groups (Figure 3.1a).

Because of the large amount of data generated by our analysis, heat-maps were used to visualise and compare trends/patterns between treatment groups using the mean gene expression level of the top 500 most variable genes (Figure 3.1b). In cells treated with 3-oxo-C_{12}-HSL alone there were two distinct clusters of differentially modulated genes, one large cluster of genes

upregulated and one small cluster of genes downregulated that clearly separated this group from the three other treatment groups (as also identified using the MDS plot). The genes highly upregulated in response to 3-oxo-C_{12}-HSL tended to be downregulated in controls, rhPON2 alone, or rhPON2+3-oxo-C_{12}-HSL treatment groups, and vice-a-versa.

Venn diagrams were constructed representing the total number of differentially expressed genes (upregulated and downregulated genes) only (Figure 3.2 a, b, c respectively) to compare cellular responses to treatment with either 3-oxo-C_{12}-HSL alone, rhPON2+3-oxo-C_{12}-HSL, or rhPON2 alone. 828 genes were upregulated in NuLi-1 cells following treatment with 3-oxo-C_{12}-HSL alone, while only 79 and 58 genes were upregulated in the same cells treated with either rhPON2+3-oxo-C_{12}-HSL, or rhPON2 alone, respectively. Conversely, 566 genes in NuLi-1 cells were downregulated in response to treatment with rhPON2+3-oxo-C_{12}-HSL compared to 3-oxo-C_{12}-HSL alone. In another comparison, the overall number of genes upregulated in cells treated with rhPON2+3-oxo-C_{12}-HSL is significantly reduced and similar to that obtained in cells treated with rhPON2 alone (Figure 3.2). Together, these data demonstrate that extracellularly applied rhPON2 strongly inhibited the gene modulatory effects of 3-oxo-C_{12}-HSL on human (NuLi-1) respiratory cells, ultimately resulting in a gene expression profile not vastly dissimilar to that of control cells and cells treated with rhPON2 alone.

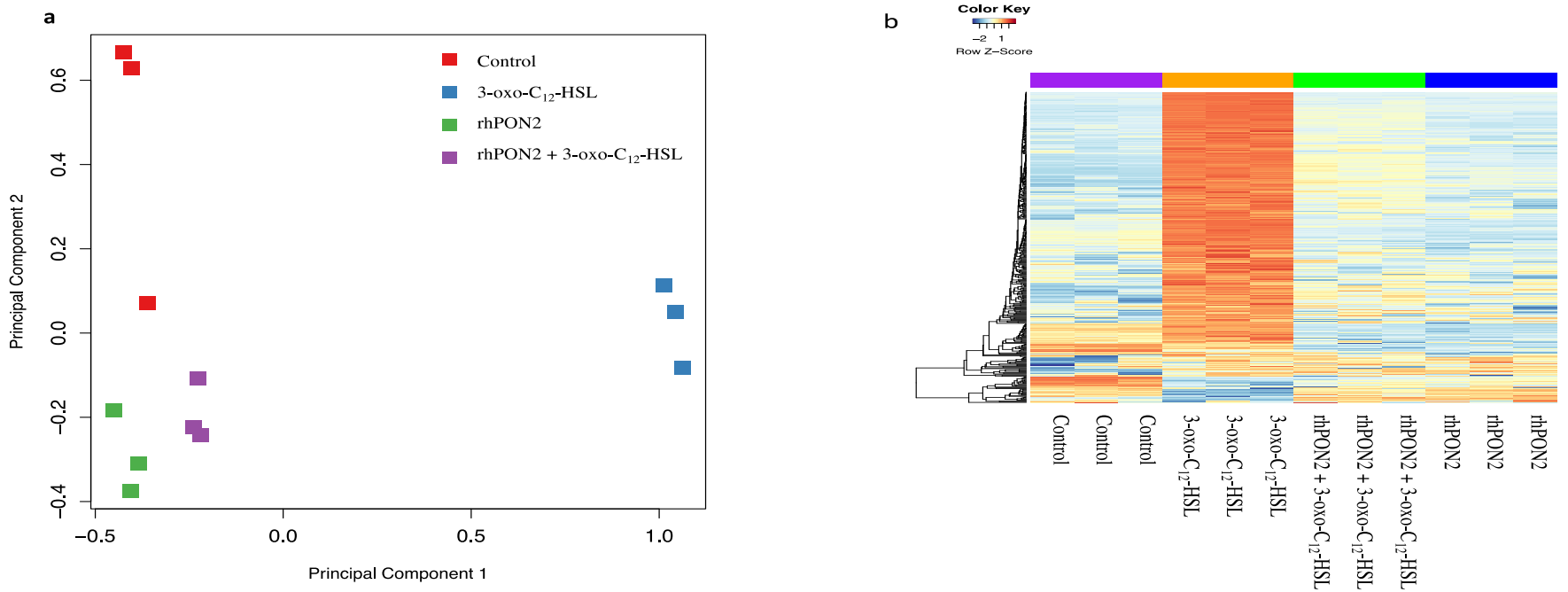
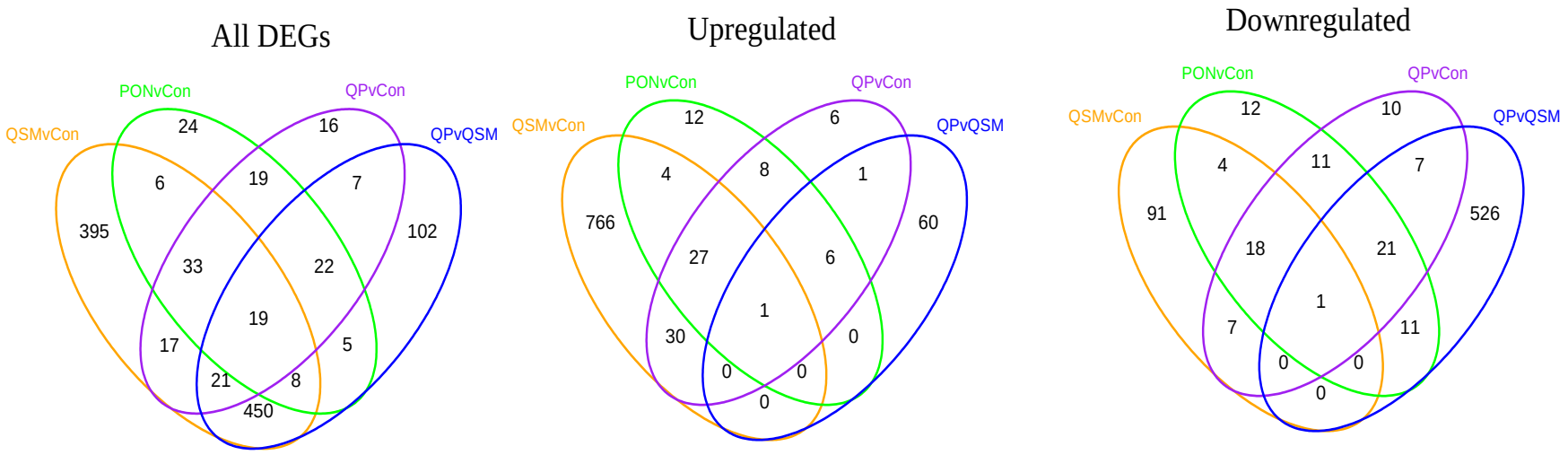


Figure 3.1. Visualisation of gene expression profiles changes in each treatment group.

NuLi-1 cells were treated with control (1% BE in 0.1 % DMSO in BGEM media), 50 µM 3-oxo-C_{12}-HSL (in vehicle), pre-treatment of 5U rhPON2 before addition of 50 µM 3-oxo-C_{12}-HSL (in vehicle) or 5U rhPON2 alone (in vehicle) for two hours at 37 °C. RNA was isolated, and gene expression and DEGs identified by RNA-seq and edgeR (FDR = 1.5), respectively. (a) The multidimensional scaling (MDS) plot of the top 500 most variable genes shows clustering of the three biological replicates for each treatment group and a clear separation between groups. (b) Visualisation of data using a heat-map. Rows correspond to each of the top 500 genes for which expression differed significantly between groups, columns correspond to treatment group and colour indicates upregulation (red) or down-regulation (blue) of that gene relative to mean expression of that gene across all groups.



	3-oxo-C_{12}-HSL vs Control (QSMvCon)	rhPON2 vs Control (PONvCon)	rhPON2 + 3-oxo-C_{12}-HSL vs Control (QPvCon)	rhPON2 + 3-oxo-C_{12}-HSL vs 3-oxo-C_{12}-HSL (QPvQSM)
All	949	136	154	634
Upregulated	828	58	79	68
Downregulated	121	78	75	566

Figure 3.2. Overview of differentially expressed genes (DEGs) in response to varying treatments.

NuLi-1 cells were treated with control (1% BE in 0.1 % DMSO in BGEM media), 50 µM 3-oxo-C_{12}-HSL (in vehicle), pre-treatment of 5U rhPON2 before addition of 50 µM 3-oxo-C_{12}-HSL (in vehicle) or 5U rhPON2 alone (in vehicle) for two hours at 37 °C. RNA was isolated, gene expression and differential gene expression analysed by RNA-seq and edgeR (FDR = 1.5), respectively. Venn diagrams of total DEGs, upregulated and downregulated genes in response to each treatment are shown. Genes included are those whose fold-change in expression were upregulated ≥ 2 or down regulated≤0.5.

3.4.2 Identification of pathways predicted to be modulated in response to treatment with 3-oxo-C_{12}-HSL

By applying kegga and goana analyses to the RNA-seq transcriptome dataset, the top ten most significant (*p*-values < 0.001) pathways predicted to be altered in response to 3-oxo-C_{12}-HSL treatment were identified (Control vs 3-oxo-C_{12}-HSL treatment summarised in Table 3.3; 3-oxo-C_{12}-HSL vs rhPON2 + 3-oxo-C_{12}-HSL treatment in Table 3.4; and Control vs rhPON2 alone in Table 3.5). Many genes whose expression was upregulated in response to treatment with 3-oxo-C_{12}-HSL (compared to controls) encode proteins that are known to be involved in regulating the immune responses (e.g. IL-17, TNF, NF-κB and NOD-like receptor signalling pathways), apoptosis (e.g. phosphatidylinositol, FoxO and NF-κB signalling pathways) and cancer related pathways (e.g. Phosphatidylinositol signalling and transcriptional misregulation in cancer pathways) (Table 3.3). It is noteworthy that the expression levels of many of these same genes were significantly downregulated in the NuLi-1 cells treated with rhPON2+3-oxo-C_{12}-HSL, including those involved in the immune responses (IL-17, TNF, NF-κB, and cytokine-cytokine receptor interaction), apoptosis (FoxO and NF-κB signalling) and cancer-related pathways (TGF-β, MAPK and transcriptional misregulation in cancer) (Table 3.4).

3-oxo-C_{12}-HSL treatment significantly downregulated the expression of many genes known to be associated with cellular metabolism (oxidative phosphorylation signalling), neurodegenerative disorders (Parkinsons, Alzheimers and Huntington signalling), cell growth (ribosome signalling), protein degradation (proteasome signalling), and cell proliferation (spliceosomes signalling) (Table 3.3). rhPON2 treatment blocked the decreased expression of those genes which should prevent modulation of these pathways (Table 3.4). In fact, expression of those genes (associated with Hippo/FoxO signalling, inflammation, and cancer, and the like) are usually upregulated in transformed cell lines, but their expression was significantly downregulated in cells treated with rhPON2 alone (Table 3.5), further supporting the protective role of extracellularly applied rhPON2.

Table 3.3. Ten most significant pathways predicted to be affected by 3-oxo-C_{12}-HSL treatment of human airway epithelial cells compare to controls

Pathways identified with DEGs mostly upregulated		**N[a]**	**Up[b]**	**Down[c]**	**P value**
path:hsa05202	Transcriptional misregulation in cancer	121	61	27	1.9E-10
path:hsa04064	NF-kappa B signalling pathway	72	38	15	1.1E-07
path:hsa03460	Fanconi anemia pathway	48	27	7	1.6E-06
path:hsa04657	IL-17 signalling pathway	73	34	14	2.0E-05
path:hsa04668	TNF signalling pathway	101	43	24	2.7E-05
path:hsa04621	NOD-like receptor signalling pathway	131	52	33	4.2E-05
path:hsa04070	Phosphatidylinositol signalling system	80	35	15	7.6E-05
path:hsa05206	MicroRNAs in cancer	136	52	45	1.3E-04
path:hsa04068	FoxO signalling pathway	107	43	33	1.4E-04
path:hsa00562	Inositol phosphate metabolism	62	28	10	2.0E-04
Pathways identified with DEGs mostly downregulated					
path:hsa03010	Ribosome	128	4	113	8.6E-34
path:hsa05012	Parkinson's disease	121	6	85	1.1E-13
path:hsa00190	Oxidative phosphorylation	114	5	81	1.5E-13
path:hsa05010	Alzheimer's disease	144	14	92	5.3E-11
path:hsa03050	Proteasome	42	0	35	1.1E-09
path:hsa05016	Huntington's disease	164	29	98	2.7E-09
path:hsa04260	Cardiac muscle contraction	42	0	31	1.6E-06
path:hsa03040	Spliceosome	129	12	73	5.4E-06
path:hsa03008	Ribosome biogenesis in eukaryotes	72	13	44	3.3E-05
path:hsa04932	Non-alcoholic fatty liver disease (NAFLD)	131	27	71	5.3E-05

[a] N = number of genes in pathway

[b] Up = number of genes in pathway upregulated with treatment compared to control.

[C] Down = number of genes in pathway down regulated with treatment compared to control

P Value = Student's two-tailed t-test

Table 3.4. Ten most significant pathways predicted to be affected by 3-oxo-C_{12}-HSL treatment of human airway epithelial cells compared to cells treated with rhPON2 and 3-oxo-C_{12}-HSL

Pathways identified with DEGs mostly upregulated		**N[a]**	**Up[b]**	**Down[c]**	**P value**
path:hsa03010	Ribosome	128	82	3	3.5E-17
path:hsa00190	Oxidative phosphorylation	114	69	3	7.3E-13
path:hsa05012	Parkinson's disease	121	71	4	2.9E-12
path:hsa05010	Alzheimer's disease	144	75	12	1.6E-09
path:hsa03050	Proteasome	42	30	0	1.0E-08
path:hsa05016	Huntington's disease	164	77	21	3.3E-07
path:hsa03040	Spliceosome	129	62	14	1.8E-06
path:hsa00010	Glycolysis / Gluconeogenesis	43	27	2	3.0E-06
path:hsa04260	Cardiac muscle contraction	42	26	0	6.8E-06
path:hsa05130	Pathogenic *Escherichia coli* infection	43	25	2	4.7E-05
Pathways identified with DEGs mostly downregulated					
path:hsa05202	Transcriptional misregulation in cancer	121	16	60	1.0E-12
path:hsa04657	IL-17 signalling pathway	73	12	34	6.4E-07
path:hsa04668	TNF signalling pathway	101	18	41	4.0E-06
path:hsa04060	Cytokine-cytokine receptor interaction	115	20	45	4.5E-06
path:hsa04010	MAPK signalling pathway	185	50	62	2.9E-05
path:hsa04350	TGF-beta signalling pathway	65	15	28	3.8E-05
path:hsa04064	NF-kappa B signalling pathway	72	12	30	4.4E-05
path:hsa05224	Breast cancer	98	19	37	7.8E-05
path:hsa04550	Signalling pathways regulating pluripotency of stem cells	102	20	38	8.8E-05
path:hsa04068	FoxO signalling pathway	107	23	39	1.2E-04

[a] N = number of genes in pathway

[b] Up = number of genes in pathway upregulated with treatment compared to control.

[C] Down = number of genes in pathway down regulated with treatment compared to control

P Value = Student's two-tailed t-test

Table 3.5. Ten most significant pathways predicted to be affected by rhPON2 alone treatment of human airway epithelial cells compared to controls

Pathways identified with DEGs mostly upregulated		**N[a]**	**Up[b]**	**Down[c]**	**P value**
path:hsa04110	Cell cycle	121	21	10	2.9E-06
path:hsa00900	Terpenoid backbone biosynthesis	20	8	0	6.6E-06
path:hsa05164	Influenza A	128	20	15	2.6E-05
path:hsa00310	Lysine degradation	53	12	0	2.8E-05
path:hsa00100	Steroid biosynthesis	19	7	1	4.8E-05
path:hsa05162	Measles	94	16	13	5.9E-05
path:hsa04660	T cell receptor signalling pathway	71	12	4	5.3E-04
path:hsa04657	IL-17 signalling pathway	73	12	12	6.9E-04
path:hsa05169	Epstein-Barr virus infection	172	20	11	1.5E-03
path:hsa04064	NF-kappa B signalling pathway	72	11	7	2.1E-03
Pathways identified with DEGs mostly downregulated					
path:hsa04060	Cytokine-cytokine receptor interaction	115	8	28	8.3E-09
path:hsa04390	Hippo signalling pathway	126	12	26	9.9E-07
path:hsa04640	Hematopoietic cell lineage	40	4	12	1.8E-05
path:hsa04550	Signalling pathways regulating pluripotency of stem cells	102	4	20	4.0E-05
path:hsa04068	FoxO signalling pathway	107	12	19	2.5E-04
path:hsa05200	Pathways in cancer	305	28	39	3.8E-04
path:hsa05224	Breast cancer	98	10	17	6.9E-04
path:hsa04668	TNF signalling pathway	101	11	17	9.9E-04
path:hsa05202	Transcriptional misregulation in cancer	121	12	19	1.2E-03
path:hsa05205	Proteoglycans in cancer	165	15	23	2.0E-03

[a] N = number of genes in pathway

[b] Up = number of genes in pathway upregulated with treatment compared to control.

[C] Down = number of genes in pathway down regulated with treatment compared to control

P Value = Student's two-tailed t-test

3.4.3 RT-qPCR validation of RNA-seq data set

To verify the expression of some of the genes in the RNA-seq dataset, the expression of 23 genes, identified as being differentially regulated by 3-oxo-C_{12}-HSL, were investigated using RT-qPCR (some of these genes are highlighted in Table 3.6). There was strong correlation between the RNA-seq and RT-qPCR gene expression (Tables 3.7 and 3.8) data. These data confirmed that 3-oxo-C_{12}-HSL upregulated the expression of genes associated with the inflammatory response (*TNFα*, *JUN*, *IL-6* and *IL-8*), stress-related heat shock response (*HSP*s), and the UPR (*ATF3*, *CHAC-1* and *XBP1*), and that the 3-oxo-C_{12}-HSL-mediated upregulation of gene expression was strongly mitigated by the rhPON2 (Table 3.8). Additionally, a comparison of the validated gene expression changes (induced by 50 μM 3-oxo-C_{12}-HSL for six hours, this study) was compared to those gene expression data from a microarray study performed by Kim *et al* (1), who investigated the response of human aortic endothelial cells (HAECs) to a four-hour treatment with 50 μM for 3-oxo-C_{12}-HSL. The RNA-seq and RT-qPCR datasets of this thesis showed a strong correlation ($r^2 = 0.99$) with those gene expression data reported by Kim *et al*. (1) (Table 3.9 a, b).

Table 3.6. A list of DEGs downregulated by rhPON2; comparison of human airway epithelial cells treated 3-oxo-C_{12}-HSLalone with cells treated with rhPON2 + 3-oxo-C_{12}-HSL.

KEGG Id	Pathway	P value	Downregulated DEGs grouped according to pathway annotation
path:hsa05202	Transcriptional misregulation in cancer	1.03E-12	**NGFR, CXCL8, IL6**, NR4A3, **MMP3**, NFKBIZ, DDIT3, ID2, BCL2A1, JMJD1C, PER2, PLAU, MAF, REL, ZBTB16, FOXO1, SIX4, GOLPH3L, BCL6, EYA1, CSF2, CDKN1A, CCNT2, TRAF1, SMAD1, MEIS1, ARNT2, UTY, CDKN1B, KLF3, MMP9, CEBPA, SLC45A3, MEF2C, RUNX1, NFKB1, ZBTB17, MLLT3, ETV1, ERG, MDM2, KMT2A, IGF1R, ZEB1, ETV5, KDM6A, NUPR1, FLI1, PBX3, CDK14, RXRB, FUT8, CCNT1, CEBPB, ATM, TFE3, PTK2, TP53, SP1, AFF1
path:hsa04657	IL-17 signalling pathway	6.40E-07	**TNF, CXCL8, IL6, MMP3**, TNFAIP3, NFKBIA, **JUN**, FOSB, CXCL3, CSF3, CXCL2, PTGS2, CCL20, FOS, CXCL1, CSF2, HSP90AA1, JUND, IL1B, MMP9, TRAF4, NFKB1, TBK1, TRAF6, TRAF2, HSP90AB1, MAPK8, CASP8, USP25, TRAF3IP2, CEBPB, TAB3, TAB2, FOSL1
path:hsa04668	TNF signalling pathway	4.02E-06	TNF, SOCS3, IL6, MMP3, TNFAIP3, JUNB, MAP3K8, NFKBIA, JUN, CXCL3, CXCL2, PTGS2, EDN1, LIF, CCL20, FOS, CXCL1, CSF2, TRAF1, CASP10, MAP3K14, IL1B, MMP9, ATF2, RPS6KA5, NFKB1, MAP2K3, CCL5, CREB3L4, CREB3L2, PIK3CD, ICAM1, MAP3K5, TRAF2, MAPK8, VEGFC, CASP8, CEBPB, TAB3, TAB2, BIRC2
path:hsa04060	Cytokine-cytokine receptor interaction	4.45E-06	**TNF, NGFR, CXCL8, IL6**, IFNL1, TNFRSF9, IL23A, CXCL3, CSF3, IL24, CXCL2, IL11, TNFSF14, IL1A, TNFSF9, LIF, CCL20, INHBA, ACKR3, CXCL1, CSF2, EPOR, TSLP, IL1B, IL7R, TNFSF15, BMPR1B, ACVR2B, PLEKHO2, CCL5, IL1R1, ACVR1, IL22RA1, ACVR1B, IFNLR1, BMPR2, ACVR2A, TGFBR1, PDGFC, VEGFC, TNFRSF10B, BMPR1A, IL1RAP, BMP2, TNFRSF12A
path:hsa04010	MAPK signalling pathway	2.92E-05	**HSPA6, HSPA1A, HSPA1B, TNF**, DUSP2, NR4A1, DUSP1, HSPA1L, DUSP10, DDIT3, **MAP3K8**, JUN, NGF, GADD45B, BDNF, DUSP8, DUSP16, IL1A, FOS, RAPGEF2, DUSP5, NFKB2, MAP3K14, JUND, IL1B, SOS2, ATF2, DUSP4, RPS6KA5, MEF2C, GADD45A, NFKB1, MECOM, MAP2K3, TRAF6, MAP4K3, IL1R1, PPM1B, RELB, SOS1, BRAF, MAP3K4, HSPA8, FGFR1, NF1, FGFR2, NFATC1, TGFBR1, MAP3K5, TRAF2, TAOK3, MAPK8, HSPB1, NFATC3, STK3, FGF2, TP53, TAB2, TAOK1, STK4, MAP3K2, RASA1
path:hsa04350	TGF-beta signalling pathway	3.83E-05	**TNF**, BAMBI, ID3, ID2, TGIF1, SMAD7, INHBA, SMAD6, BMP4, CDKN2B, SMAD1, BMPR1B, CREBBP, ACVR2B, ID1, ACVR1, ACVR1B, ZFYVE16, EP300, BMPR2, ACVR2A, TGFBR1, THBS1, BMPR1A, RBL1, SMURF1, SP1, BMP2
path:hsa04064	NF-kappa B signalling pathway	4.41E-05	**TNF, CXCL8**, TNFAIP3, NFKBIA, GADD45B, CXCL2, BCL2A1, PTGS2, TNFSF14, PLAU, NFKB2, TRAF1, MAP3K14, BCL10, IL1B, TICAM1, NFKB1, TRAF6, IL1R1, RELB, XIAP, PLCG1, ERC1, ICAM1, TRAF2, TRIM25, ATM, TAB3, TAB2, BIRC2

Highlighted genes were validated by RT-qPCR. P-value Student's two-tailed t-test.

Table 3.7. Correlation between RNA-seq and RT-qPCR gene expression analyses.

RNA-seq vs RT-qPCR	Correlation[a]
Control vs 3-oxo-C_{12}-HSL	+0.99326635
Control vs rhPON2	+0.67120912
3-oxo-C_{12}-HSL vs rhPON2 +3-oxo-C_{12}-HSL	+0.99112932

[a] correlation determined using the Pearson's Correlation co-efficient

Table 3.8. Comparison of the differential expression of 23 genes in response to varying treatment, measured using RNA-seq and RT-qPCR

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	RT-qPCR data						RNA-seq data					
	Control vs 3-oxo-C_{12}-HSL		Control vs rhPON2		3-oxo-C_{12}-HSL vs rhPON2 + 3-oxo-C_{12}-HSL		Control vs 3-oxo-C_{12}-HSL		Control vs rhPON2		3-oxo-C_{12}-HSL vs rhPON2 + 3-oxo-C_{12}-HSL	
Gene	**FC**	**P value**	**FC**	**P value**	**FC**	**P value**	**FC**	**P value**	**FC**	**P value**	**FC**	**P value**
IL6	3.80	2.00E-05	-1.72	1.00E-03	-5.90	6.90E-06	3.34	2.81E-17	-1.84	2.70E-07	-4.96	7.19E-19
CXCL8	8.58	2.80E-06	1.09	6.40E-01	-7.60	3.10E-06	7.34	6.85E-27	1.04	5.50E-01	-6.14	1.60E-26
TNF	7.75	2.09E-06	1.30	3.00E-01	-3.90	2.00E-05	17.18	6.40E-12	2.27	2.64E-02	-7.07	7.76E-11
ATF3	2.90	5.00E-05	-1.11	2.20E-01	-3.40	1.50E-05	2.77	1.09E-19	-1.21	7.69E-04	-3.01	2.46E-20
XBP1	1.80	8.00E-04	1.06	6.40E-01	-1.60	1.60E-03	1.58	1.00E-16	-1.03	3.77E-01	-1.36	7.03E-13
ATF4	1.10	6.00E-01	1.14	5.00E-01	-1.12	4.80E-01	1.14	4.70E-07	1.06	5.12E-02	-1.01	5.59E-01
JUN	3.00	8.00E-05	1.00	7.00E-01	-3.00	7.70E-05	2.77	2.03E-21	1.11	2.06E-02	-2.58	1.01E-20
PPARG	1.10	8.90E-01	-1.11	5.00E-01	-1.16	8.60E-01	1.02	8.01E-01	-1.01	9.71E-01	-1.02	8.06E-01
CHAC1	4.50	5.00E-04	1.00	8.52E-01	-3.70	7.60E-04	4.22	8.31E-23	-1.10	1.43E-01	-3.28	1.08E-21
HSPA1A	10.86	3.71E-10	1.00	5.00E-01	-9.83	5.46E-10	12.08	9.69E-30	1.11	4.07E-02	-11.73	1.46E-29

HSPA1B	11.06	7.85E-09	-1.11	9.00E-01	-10.30	1.07E-08	8.58	5.50E-28	-1.02	8.23E-01	-9.18	4.23E-28
HSPA6	130.63	3.66E-06	-1.25	9.00E-02	-105.22	3.73E-06	114.70	9.05E-24	-1.17	5.60E-01	-139.29	1.14E-23
HSPA1L	4.56	4.15E-12	1.14	1.90E-01	-2.56	3.86E-04	5.30	1.39E-13	1.45	4.05E-02	-4.45	3.21E-13
DNAJA4	8.51	8.82E-06	-1.11	4.20E-01	-8.22	9.11E-06	8.11	1.08E-24	1.06	5.69E-01	-8.11	5.56E-25
DNAJB1	4.83	6.08E-08	-1.11	3.80E-01	-5.23	4.59E-08	4.52	3.81E-27	1.12	1.32E-03	-4.21	9.14E-27
ARC	14.09	2.02E-05	-1.11	6.00E-01	-9.13	1.22E-04	16.48	5.30E-16	-1.55	1.54E-01	-26.06	3.13E-16
BAG3	2.93	1.58E-07	1.00	1.20E-01	-2.37	2.98E-05	2.77	1.20E-24	1.16	7.33E-06	-2.41	2.27E-23
MAP3K8	9.22	2.93E-10	2.70	3.00E-02	-2.62	4.90E-05	3.44	2.38E-12	1.13	5.27E-01	-2.65	3.90E-11
NGFR	9.08	5.01E-06	-1.25	9.80E-01	-7.83	6.51E-06	8.25	1.02E-19	-1.28	9.83E-02	-6.15	1.49E-19
MMP3	5.24	2.32E-03	-1.43	9.00E-04	-4.86	2.61E-03	4.16	2.23E-12	-1.15	5.45E-01	-4.00	2.31E-12
MMP10	5.07	2.52E-05	-1.43	8.00E-04	-4.28	4.05E-05	5.26	3.44E-09	-1.31	5.03E-01	-7.08	7.03E-10
EGR1	18.99	4.13E-09	1.98	5.95E-07	-8.59	8.47E-09	17.24	1.81E-30	2.32	3.37E-17	-6.85	2.42E-27
EDN1	-1.221	5,17E-04	-2.38	1.44E-09	-1.82	1.82E-04	-1.39	1.35E-05	-2.44	6.54E-11	-1.89	2.32E-08

Results represent FC ± SEM of $n = 3$ and P-value (Student's two-tailed t-test).

Table 3.9a. 3-oxo-C_{12}-HSL-induced changes in gene expression identified in the present study (measured using both RT-qPCR and RNA-seq) compared to previously published data (1).

	RT-qPCR data (this study)		RNA-seq data (this study)		Microarray data (Kim *et al.* 2011)	
	Fold-change	**P value**	**Fold-change**	**P value**	**Fold-change**	**P value**
Gene						
IL-8	8.58	2.80E-06	7.34	6.85E-27	2.71	1.11E-02
ATF3	2.90	5.00E-05	2.77	1.09E-19	2.59	1.79E-04
XBP1	1.80	8.00E-04	1.58	1.00E-16	1.63	4.55E-04
HSPA1A	10.86	3.71E-10	12.08	9.69E-30	5.2	1.94E-06
HSPA1B	11.06	7.85E-09	8.58	5.50E-28	2.75	5.70E-04
HSPA6	130.63	3.65E-06	114.70	9.05E-24	47.9	1.97E-03
DNAJA4	8.51	8.82E-06	8.11	1.08E-24	4.96	1.95E-05
DNAJB1	4.83	6.07E-08	4.52	3.81E-27	2.05	1.06E-03
BAG3	2.93	1.58E-07	2.77	1.20E-24	2.89	5.04E-05
NGFR	9.08	5.01E-06	8.25	1.02E-19	3.69	7.23E-08
MMP10	5.07	2.51E-05	5.26	3.44E-09	3.11	2.63E-15
EDN1	0.81	5.20E-04	0.71	1.35E-05	0.75	9.05E-06

Results represent FC ± SEM of $n = 3$ and P value (Student's two-tailed t-test).

Table 3.9b. Correlation between 3-oxo-C_{12}-HSL-induced differential gene expression in this study compared to previously published data by Kim and colleagues (2011) (1)

	Correlation[a]
Control vs 3-oxo-C_{12}-HSL RT-qPCR vs Kim microarray	+0.9983
Control vs 3-oxo-C_{12}-HSL RNA-seq vs Kim microarray	+0.9975

[a] correlation determined using the Pearson's Correlation co-efficient.

3.4.4 rhPON2 protects airway epithelial cells from 3-oxo-C_{12}-HSL-induced morphological changes

Several studies revealed the disruptive effect of 3-oxo-C_{12}-HSL on epithelial barrier morphology and integrity (56, 57, 61). Consistent with these reports, this study identified 3-oxo-C_{12}-HSL-mediated modulation of expression of genes associated with maintaining epithelial barrier function and cytoskeletal remodelling (genes detailed in Table 3.10). For example, the transcriptome analysis demonstrated that exposure of host cells to 3-oxo-C_{12}-HSL lead to the upregulated expression of many genes with a known role in the MAPK signalling pathway (e.g. *MAP3K8, MAP3K14* and *MAPK8*) and the *MMP3* gene whose protein products are predicted to be involved in degrading tight junction (TJ) proteins and weakening epithelial barriers (61). The expression levels of several other genes associated with maintaining adheren

junctions (*CDH1* and *CTNNB1*) and cytoskeleton remodelling (*RhoA, RhoB, RAC1*, *CDC42* and *IQGAP1*) were also all downregulated in cells exposed to 3-oxo-C_{12}-HSL. To verify that these measured changes in gene expression were associated with observable changes in cell integrity, the effect of 3-oxo-C_{12}-HSL on NuLi-1 cell morphology was investigated using light microscopy. Treating the NuLi-1 with 3-oxo-C_{12}-HSL for two hours altered their morphology, causing them to 'round up' and to lose cell-to-cell contact, consistent with this transcriptome analysis and the previously reported disruptive effects of 3-oxo-C_{12}-HSL on host epithelial barrier integrity (57) (Figure 3.3).

Importantly, addition of rhPON2 to 3-oxo-C_{12}-HSL treated cells resulted in down-regulation of many genes in the MAPK signalling pathway that were upregulated by the 3-oxo-C_{12}-HSL alone treatment and blocked the 3-oxo-C_{12}-HSL-mediated down-regulation of the *CDH1*, *CTNNB1*, *RhoA, RhoB, RAC1, CDC42* and *IQGAP1* genes. The rhPON2 also blocked the 3-oxo-C_{12}-HSL-mediated upregulation of the *MMP3* (Table 3.10). Consistent with these changes in gene expression, the morphology of the NuLi-1 cells that was changed by the 3-oxo-C_{12}-HSL alone treatment remained essentially unchanged in the presence of rhPON2+3-oxo-C_{12}-HSL or rhPON2 alone (Figure 3.3).

Table 3.10. rhPON2 prevents the effects of 3-oxo-C_{12}-HSL-mediated change in expression of genes involved in epithelial barrier function and tissue remodelling.

	Control vs 3-oxo-C_{12}-HSL		**3-oxo-C_{12}-HSL vs rhPON2 +3-oxo-C_{12}-HSL**	
Gene	Log_2 Fold-change	P- value	Log_2 Fold-change	P-value
CTNNB1	-0.2178	4.77E-07	0.099	6.32E-03
CDH1	-0.162	1.55E-05	0.154	4.36E-05
MMP3	2.000	3.34E-09	-2.000	6.80E-10
IQGAP1	-0.133	1.28E-04	0.119	6.14E-04
RAC1	-0.225	8.53E-08	0.151	4.64E-05
CDC42	-0.361	1.76E-09	0.266	5.37E-07
RHOA	-0.220	9.20E-08	+0.16	1.56E-05
RHOB	-0.530	1.22E-07	+0.45	2.77E-06

Results represent log_2 FC ± SEM of n = 3 and P value based on Student's two-tailed t-test

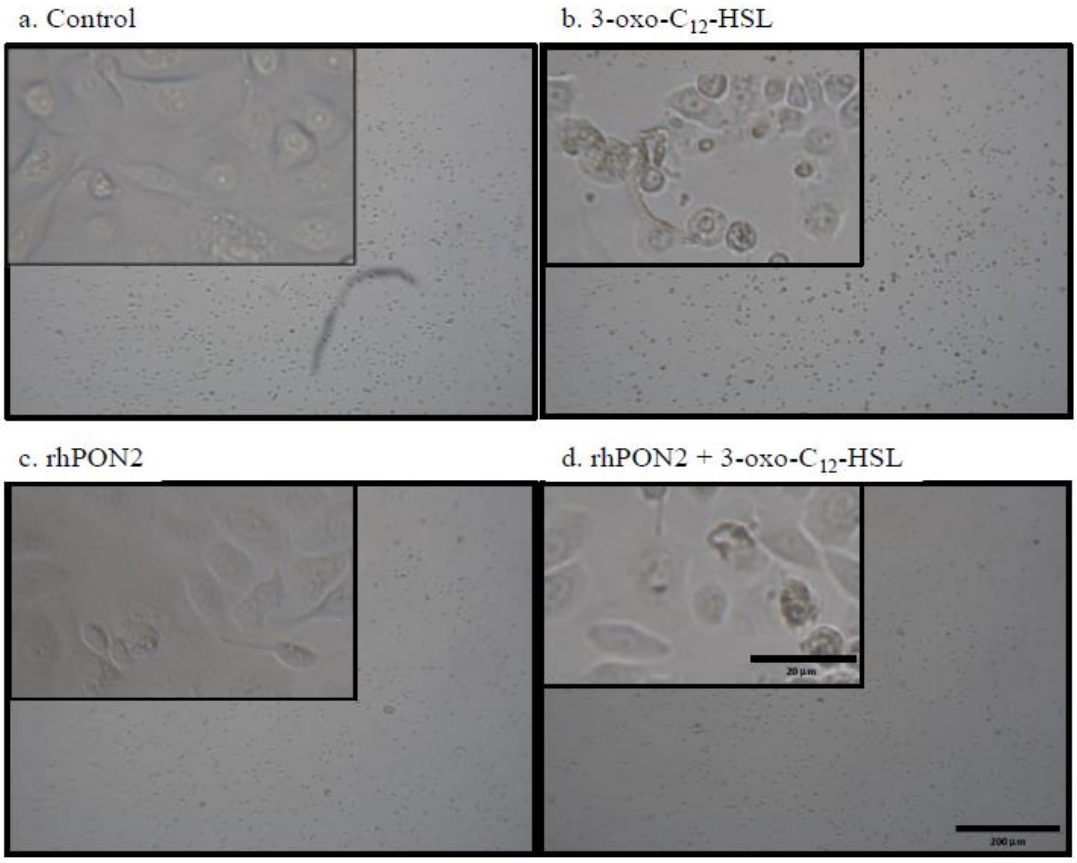

Figure 3.3. rhPON2 prevents 3-oxo-C_{12}-HSL-induced morphological changes in NuLi-1 cell morphology.

NuLi-1 cells were treated with (a) vehicle control (0.1% DMSO, 1% Buffer E in BGEM media), (b) 50 µM 3-oxo-C_{12}-HSL (in vehicle), (c) 5 U rhPON2 (in vehicle) and (d) rhPON2 + 50 µM 3-oxo-C_{12}-HSL (in vehicle) for two hours at 37 °C with 5% CO_2. Cells were visualised using a Leica DM IL light microscope at 400 x magnification for inset image and 40 x for outset image. Images were captured and acquired using a Leica DFC320 digital camera and Leica Firecam v3.4.1 software, respectively.

3.4.5 rhPON2 prevents 3-oxo-C_{12}-HSL-induced IL-6 and IL-8 release

The pro-inflammatory effects of 3-oxo-C_{12}-HSL have been widely reported (167). Gene expression analysis undertaken in this study confirmed that 3-oxo-C_{12}-HSL was a potent inducer of inflammation as evidenced by the 3-oxo-C_{12}-HSL-mediated induction of expression of many inflammatory genes, including *IL-6* and *IL-8* (Table 3.3 and 3.8). To demonstrate that this 3-oxo-C_{12}-HSL-mediated change in gene expression was associated with modulation of inflammation, IL-6 and IL-8 cytokine release by NuLi-1 cells were measured after exposure to

0, 10 or 50 μM 3-oxo-C_{12}-HSL for six hours in the presence or absence of rhPON2. As expected, treatment of cells with 50 μM 3-oxo-C_{12}-HSL resulted in significantly increased levels of IL-6 ($p = 0.009$) and IL-8 ($p = 0.0017$) in culture supernatants compared to controls (see Figure 3.4 black bars). When cells were first treated with rhPON2 (grey bars) prior to the addition of 3-oxo-C_{12}-HSL, rhPON2 blocked the 3-oxo-C_{12}-HSL induced secretion of both cytokines.

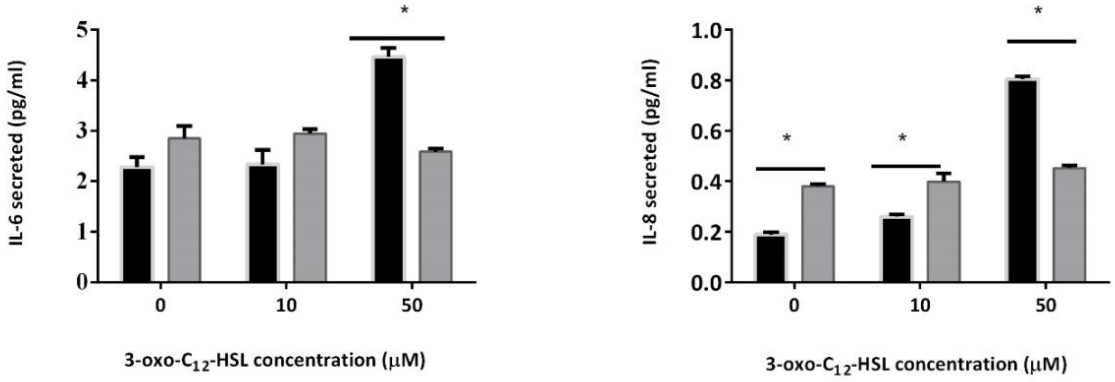

Figure 3.4. rhPON2 prevents 3-oxo-C_{12}-HSL-mediated induction of IL-6 and IL-8 release.

NuLi-1 cells were pre-treated with buffer E (black bars) or 5 U rhPON2 (grey bars) in vehicle (0.1% DMSO, 1% Buffer E in BGEM media) before exposure to 0, 10 or 50 μM 3-oxo-C_{12}-HSL. Cells were incubated for six hours at 37 °C with 5% CO_2. Supernatants were collected, clarified and IL-6 and IL-8 was measured in 100 μl duplicate aliquots. Results are expressed in mean pg/ml ± SEM of $n = 3$, * = $P \leq 0.05$ (Student's two-tailed t-test).

3.4.6 rhPON2 prevents 3-oxo-C_{12}-HSL-induced apoptosis

Gene expression analysis of 3-oxo-C_{12}-HSL treated cells identified 3-oxo-C_{12}-HSL-mediated upregulation of many genes whose products are potentially involved in apoptosis, including those genes associated with the phosphatidylinositol and NF-κB signalling pathways. The transcriptome analysis demonstrated that 3-oxo-C_{12}-HSL upregulated genes whose proteins are known to be associated with the intrinsic (*caspases 2* and *9*) and extrinsic (*caspase 8AP2* and *10* and *TNFRSF9*) apoptosis pathways. Additionally, 3-oxo-C_{12}-HSL treatment significantly upregulated the expression of several other pro-apoptotic genes (*BCL2L11/BIM, PMAIMP1, BCL2A1* and *BCL2L13*), while it simultaneously downregulated the expression of certain anti-apoptotic genes (*BCL2L2* and *BCL7C*) compared to controls, which is consistent with 3-oxo-

C_{12}-HSL being a potent inducer of apoptosis. Remarkably, rhPON2 treatment blocked the 3-oxo-C_{12}-HSL-mediated effects on the expression of these apoptosis-related genes and pathways (see Table 3.11).

To demonstrate that 3-oxo-C_{12}-HSL treatment induces apoptosis, a caspase 3/7 activity assay was performed. Caspase 3 and 7 activity seems to increase in the final stages of apoptosis, and as such an increase in caspase 3/7 activity is assumed to be a strong indicator of cells undergoing apoptosis (99). NuLi-1 cells were treated with 50 μM 3-oxo-C_{12}-HSL alone or in combination with 5 U rhPON2 for two hours before caspase 3/7 activity was measured. The 3-oxo-C_{12}-HSL treatment significantly increased caspase 3/7 activity in the NuLi-1 cells ($p = 0.017$), an effect that was diminished in cells treated with rhPON2+3-oxo-C_{12}-HSL (Figure 3.5).

Table 3.11. rhPON2 prevents 3-oxo-C_{12}-HSL-induced modulation of genes known to be involved in inducing apoptosis.

Gene	**Control vs 3-oxo-C_{12}-HSL**		**3-oxo-C_{12}-HSL vs rhPON2 + 3-oxo-C_{12}-HSL**	
	Log_2 Fold-change	**P-value**	**Log_2 Fold-change**	**P-value**
BCL2L11/BIM	0.66	9.06E-10	-0.93	2.29E-12
PMAIP1/NOXA	1.53	4.51E-19	-1.20	1.89E-17
BCL2A1	1.15	2.37E-06	-1.18	2.01E-06
BCL2L13	0.26	5.33E-07	-2.50	1.28E-06
BCL2L2	-0.31	1.00E-04	0.27	1.00E-03
BCL7C	-0.25	2.14-04	0.19	2.54E-03
TNFRSF9	1.67	2.12E-07	-1.56	1.48E-14
Caspase 8AP2	0.412	4.00E-10	-0.43	2.14E-10
Caspase 10	0.711	3.13 E-6	-0.530	3.00E-4
Caspase 9	0.484	7.06E-5	-0.546	7.60E-5
Caspase 2	0.14	5.00E-4	-0.158	1.00E-4

Results represent log_2 FC ± SEM of n = 3 and P value based on Student's two-tailed t-test.

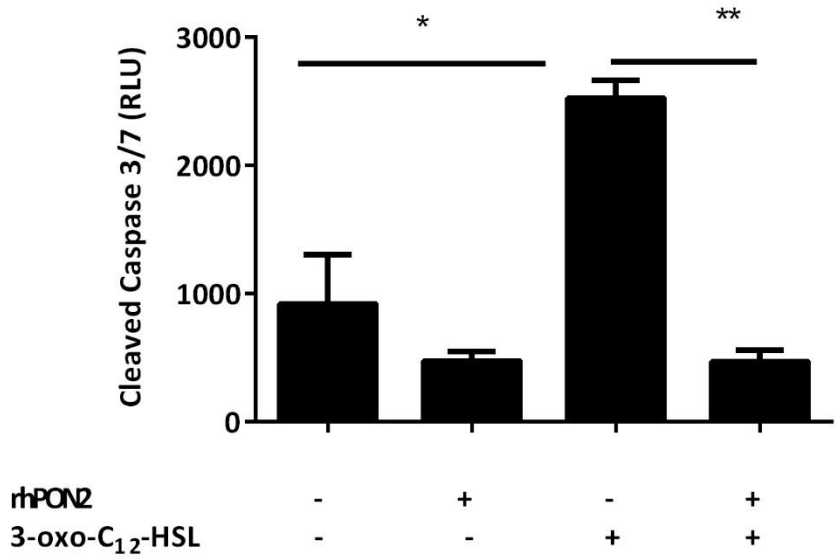

Figure 3.5. rhPON2 prevents 3-oxo-C_{12}-HSL-mediated induction of apoptosis.
NuLi-1 cells were treated with vehicle control (0.1% DMSO, 1% Buffer E in BGEM media), 5 U rhPON2 (in vehicle) ten minutes prior to the addition of 50 μM 3-oxo-C_{12}-HSL (in vehicle) then incubated for two hours at 37 °C with 5% CO_2. After two hours incubation, the Caspase-Glo® 3/7 Reagent (Promega, Madison Wisconsin) was added and the cells incubated for an additional 30 minutes before luminescence was measured using the SpectraMax M2 plate-reader. Caspase 3/7 activity was based on relative light units (RLU). Results represent mean (RLU) ± SEM of n = 3, * = P $\leq$ 0.05, ** = P $\leq$ 0.01, (Student's two-tailed t-test).

3.4.7 rhPON2 prevents the 3-oxo-C_{12}-HSL-induced reduction in cellular metabolic activity

The transcriptome analysis demonstrated that 3-oxo-C_{12}-HSL treatment resulted in down-regulation of expression of genes involved in the oxidative phosphorylation (OxPhos) pathway such as cytochrome C (*CYCS*) and nicotinamide adenine dinucleotide kinase (*NADK)*, see Table 3.12). The kinase encoded by *NADK* plays a critical role in control of mammalian cellular metabolism by regulating levels of nicotinamide adenine dinucleotide phosphate (NADPH). To demonstrate that 3-oxo-C_{12}-HSL-mediated changes in OxPhos related gene expression alters cell metabolism, a resazurin-based assay was used. Resazurin is a redox indicator reduced in the mitochondria to resarufin by NADPH, and hence provides an efficient readout for cell metabolism/viability (168). Exposure of NuLi-1 cells to 3-oxo-C_{12}-HSL significantly diminished (P= 0.001) the capacity of cells to reduce resazurin to resarufin, consistent with

transcriptomic data and a previous report (1). Importantly, this study also demonstrated that treatment of cells with rhPON2+3-oxo-C_{12}-HSL prevented the 3-oxo-C_{12}-HSL-mediated decrease in cellular metabolism (Figure 3.6), maintaining metabolism at a level comparable to controls and rhPON2 treatment alone.

Table 3.12. rhPON2 prevents 3-oxo-C_{12}-HSL-mediated down-regulation of genes involved in controlling cellular metabolism.

Genes	Control vs 3-oxo-C_{12}-HSL		3-oxo-C_{12}-HSL vs rhPON2 + 3-oxo-C_{12}-HSL	
	Log_2 Fold-change	**P value**	**Log_2 Fold-change**	**P value**
CYCS	-0.34	1.33E-07	0.26	1.09E-05
NADK	-0.20	8.06E-05	0.12	1.20E-02

Results represent log_2 FC ± SEM of n = 3 and P value based on two tailed Student's t-tests.

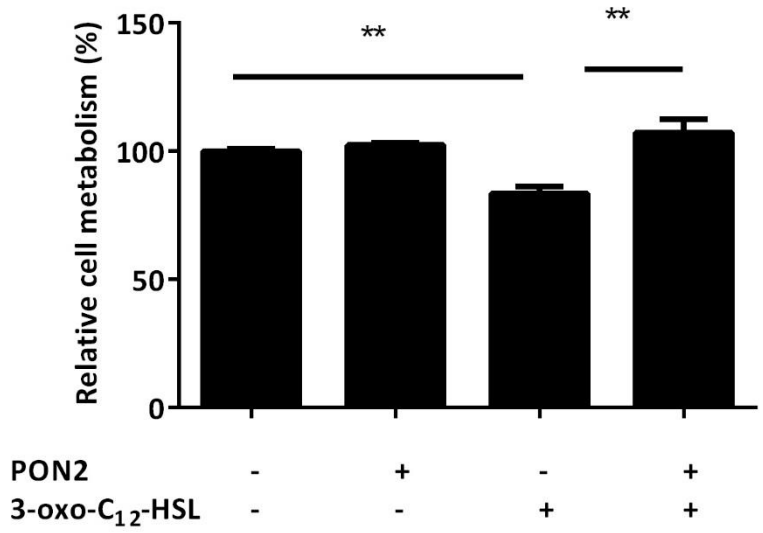

Figure 3.6. rhPON2 prevents 3-oxo-C_{12}-HSL-mediated reduction in cell metabolism.
NuLi-1 cells were treated with vehicle control (0.1% DMSO, 1% Buffer E in BGEM media), 5 U rhPON2 (in vehicle) ten minutes prior to the addition of 50 μM 3-oxo-C_{12}-HSL (in vehicle) then incubated for two hours at 37 °C with 5% CO_2. After incubation for two hours, resazurin was added to a final concentration of 44 μM and cell metabolism measured after two hours. Results are expressed as % cell metabolism relative to control and represent means ± SEM of n = 4, ** = P≤ 0.01 (Student's two-tailed t-test).

3.4.8 rhPON2 prevents the 3-oxo-C_{12}-HSL-mediated reduction in cellular glutathione levels (GSH)

Gene expression analysis identified that 3-oxo-C_{12}-HSL-mediated the upregulation of several UPR genes, including *ATF3*, *XBP1* and *CHOP/DDIT3* (see Tables 3.7 and 3.13), consistent

with a previous report that demonstrated a 3-oxo-C_{12}-HSL-mediated upregulation in expression of these genes in human aortic endothelial cells (1). CHOP can mediate apoptosis either by activation of effector caspases such as Caspase 3/7, or else by depleting cellular glutathione levels and disrupting redox homeostasis (169). The transcriptome analysis highlighted several genes and pathways that were modulated by 3-oxo-C_{12}-HSL and whose products are potentially involved in reducing glutathione levels (table 3.13). Thus for example, 3-oxo-C_{12}-HSL treatment of cells upregulated *CHAC1* gene expression, a pro-apoptotic component of the UPR downstream of the AT4/ATF3/CHOP pathway (81, 170), whose protein product, CHAC1, was recently demonstrated to degrade glutathione (171). Additionally, 3-oxo-C_{12}-HSL upregulated the expression of the gamma-glutamyltransferase (*GGT1*) gene, which normally encodes an enzyme that specifically targets and degrades glutathione (172). Furthermore, 3-oxo-C_{12}-HSL treatment downregulated *GPX4* and *GCLM* gene expression, whose products protect against lipid peroxidation and play a role in maintaining overall glutathione metabolism, respectively (1, 74, 75, 82). In this study, treatment of cells with 3-oxo-C_{12}-HSL led to a reduction in cellular glutathione levels ($P = 0.001$) and this effect could be mitigated by co-treatment of cells with rhPON2 ($P = 0.003$, Figure 3.7).

Table 3.13. rhPON2 blocks the 3-oxo-C_{12}-HSL-induced modulation of genes involved in glutathione metabolism and degradation.

Genes	**Control vs 3-oxo-C_{12}-HSL**		**3-oxo-C_{12}-HSL vs rhPON2 + 3-oxo-C_{12}-HSL**	
	Log_2 Fold-change	**P value**	**Log_2 Fold-change**	**P value**
CHAC1	2.07	9.31E-26	-1.71	9.49E-22
GGT1	1.29	1.88E-05	-0.70	4.00E-03
GPX4	-0.15	3.00E-03	0.12	1.40E-02
GCLM	-0.20	2.00E-03	0.22	1.00E-03
CHOP/DDIT3	2.12	9.35E-22	-1.71	1.06E-20

Results represent log_2 FC ± SEM of $n = 3$ and P value based on Student's two-tailed t-test.

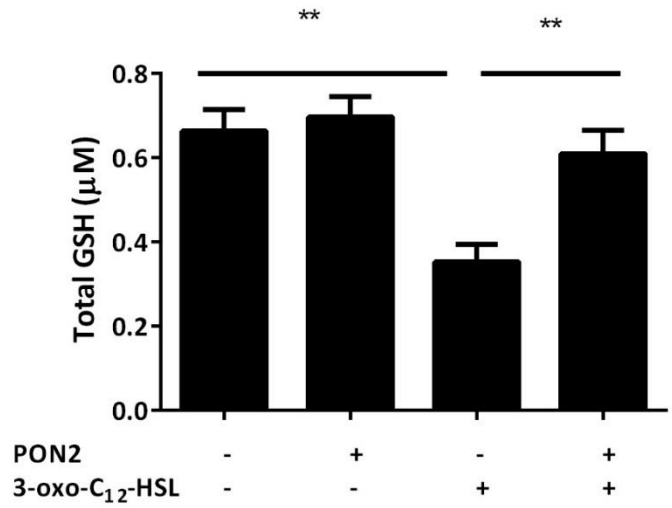

Figure 3.7. Treatment of cells with rhPON2 prevents the 3-oxo-C_{12}-HSL-induced reduction in cellular glutathione levels.

NuLi-1 cells were treated with vehicle control (0.1% DMSO, 1% Buffer E in BGEM media), 5 U rhPON2 (in vehicle) ten minutes prior to the addition of 50 µM 3-oxo-C_{12}-HSL (in vehicle) then incubated for two hours at 37 °C with 5% CO_2. After two hours incubation, total glutathione was measured using the GSH-glo™ (Promega, Madison Wisconsin) kit. Results represent means ± SEM of n = 3, ** = $P \leq 0.01$ (Student's two-tailed t-test).

3.5 Discussion

In this chapter, global gene expression changes in human airway epithelial cells mediated by exposure to 3-oxo-C_{12}-HSL was examined in detail before the ability of rhPON2 treatment to mitigate these effects was examined for the first time. When human respiratory epithelial cells were exposed to 3-oxo-C_{12}-HSL there was significant and dramatic modulation of gene expression, with 949 genes being differentially expressed (828 upregulated and 121 downregulated), which included those associated with inflammation, maintenance of epithelial barrier integrity, cytoskeletal remodelling, apoptosis and other cell stress responses. The most important findings of this study are discussed below.

Airway epithelial cells provide both physical and immune barriers to pathogens and other environmental agents. They form a selective but permeable barrier consisting of tight junction (TJ) proteins (occulin and tricellum) that regulate the paracellular transport of ions, and adherent junction (AJ) proteins (E-cadherin and β-catenin) responsible for the initiation and maintenance of cell-cell adhesion (53). Several previous studies demonstrated that 3-oxo-C_{12}-

HSL treatment reduced epithelial barrier function by reducing trans-epithelial electrical resistance (TER), and by diminishing the production and distribution of TJ proteins such as occulin and tricellum and adherent junction proteins such as E-cadherin and β-catenin (61, 173). Vikstom and colleagues (2006) (57) suggested that the decrease in TJ proteins and TER was partly regulated by 3-oxo-C_{12}-HSL activation of the p38- and p42/44 MAPK-dependent pathways, since pharmacological inhibition of these pathways restored TJ protein levels and TER to levels similar to that of controls. In addition, Eum and colleagues (2014) (61) suggested that the 3-oxo-C_{12}-HSL-mediated decrease in TJ proteins occurred via MMPs (like MMP-3) since MMP3 inhibition mitigated the 3-oxo-C_{12}-HSL-mediated loss of TJ proteins. This is similar to the results of this transcriptome analysis, which demonstrated that 3-oxo-C_{12}-HSL treatment increased the expression of genes belonging to the MAPK signalling pathway and that of the *MMP3* gene, as well as decreased the expression of some genes coding for adheren junction proteins.

In response to injury such as inflammation, oxidative stress and or infection, epithelial cells undergo a wound healing process that involves restoration of the epithelial barrier and is reliant on extensive re-organisation of the cytoskeleton and cellular junctions. This process is partly regulated by the Rho family of small GTPases such as Rho, Rac, and Cdc42 that are involved in cell migration (58). Research by Karlsson and colleagues (59) demonstrated that high concentrations of 3-oxo-C_{12}-HSL reduced IQGAP1 protein and Cdc42 and Rac1 phosphorylation levels in epithelial cells. In support of this, the transcriptomic analysis presented here demonstrated that 50 μM 3-oxo-C_{12}-HSL reduced *IQGAP1, Cdc42, Rac1, RhoA,* and *RhoB* gene expression. Consistent with this transcriptomic analysis and previous studies (57) cells exposed to 3-oxo-C_{12}-HSL for two hours rounded up and appeared to lose cell-to-cell contact, an indicator of reduced host epithelial barrier integrity. Collectively, these data partially explain the destructive effects of 3-oxo-C_{12}-HSL on epithelial barrier integrity, which could facilitate the invasion and establishment of *P. aeruginosa* into lung tissue and facilitate the establishment of chronic infection and exaggerated inflammation (54, 68).

Airway epithelial cells also play an important role in the innate immune system. They facilitate mucociliary clearance of microorganisms, and produce antimicrobial peptides such as lysozyme, lactoferrin, and mucins, as well as secrete chemokines and cytokines important for recruitment of immune cells (neutrophils) to sites of infection (52). It has been well-documented that 3-oxo-C_{12}-HSL at high concentration (50μM) induced a pro-inflammatory (IL-6, IL-8 and TNFα) response in airway epithelial cells (1, 69, 71, 75). The ability of 3-oxo-

C_{12}-HSL to provoke a pro-inflammatory response in airway epithelial cells appears to be related to its already well-known capacity to induce phosphorylation of the extracellular signal regulated and mitogen activated kinases ERK/MAPK, leading to the activation and nuclear localisation of NF-κB (1, 71, 75). Alternatively, Kim and colleagues suggested that the 3-oxo-C_{12}-HSL-mediated upregulation of pro-inflammatory genes expression, e.g. *IL-8* is mediated by activation of the UPR (3). Consistent with this, the UPR transcription factors ATF4 and XBP1 were demonstrated to be essential mediators of inflammation since knock down of ATF4 and/or XBP1 by siRNA in human aortic endothelial cells was accompanied by significantly reduced *IL-8* and *IL-6* gene expression (80, 81). The transcriptome analysis undertaken in the present study demonstrated that 3-oxo-C_{12}-HSL induced a pro-inflammatory response (*IL-6*, *IL-8* and *TNFα)* in airway epithelial cells. This was further confirmed by the increased release of IL-6 and IL-8 cytokines from respiratory cells treated with 3-oxo-C_{12}-HSL. Furthermore, the transcriptome analysis demonstrated that 3-oxo-C_{12}-HSL upregulated expression of several genes associated with the NF-κB signalling pathway (*REL*, *NκB2*, and *EGR1*), and the TNFα signalling pathways consistent with previous reports (69, 71, 75). Collectively, these data support 3-oxo-C_{12}-HSL being a potent inducer of the pro-inflammatory response (92).

The 3-oxo-C_{12}-HSL of *P. aeruginosa* was shown in numerous studies to induce apoptosis via the so-called intrinsic and extrinsic (mitochondria-dependent) pathways (92, 93, 174). In this study, 3-oxo-C_{12}-HSL potentially induced apoptosis in the NuLi-1 cells by upregulating the expression of several genes whose proteins are associated with the intrinsic apoptosis pathway (*caspases 2* and *9*) and extrinsic apoptotic pathway (*TNFRSF9, caspase 8 AP2* and *caspase 10)*. These data are reminiscent of a report by Schwarzer and colleagues (2012) (174) who demonstrated that 3-oxo-C_{12}-HSL treatment increased both capsase-8 (intrinsic apoptosis) and caspase-9 (extrinsic apoptosis) activity in respiratory epithelial cells. In addition, the RNA-seq-based transcriptome analysis extends our current understanding of the pro-apoptotic effects of 3-oxo-C_{12}-HSL by identifying a significant 3-oxo-C_{12}-HSL-mediated increase in expression of several other pro-apoptotic genes (*BCL2L11, PMAIMP1, BCL2A1* and *BCL2L13*) and simultaneous downregulation of expression of certain anti-apoptotic genes (*BCL2L2* and *BCL7C*) compared to controls. It will be remembered that production of caspase 3 and 7 is usually increased in the final stages of apoptosis (99). The 3-oxo-C_{12}-HSL treatment of airway epithelial cells increased the activity of the effector caspases 3/7 compared to control cells, consistent with previous reports (1, 175).

Apoptosis can also occur via activation of CHOP via the IRE1α and/or PERK branch of the UPR, where overproduction of CHOP induces cell cycle arrest and apoptosis by activating the expression of the pro-apoptotic BH3-only (BIM) protein (98). This in turn, activates production of Bax/Bak proteins increasing mitochondrial outer membrane permeability (MOMP) and cytochrome C release, eventually leading to caspase 3 activation and apoptosis (98, 176). In addition, CHOP induces apoptosis by depleting cellular glutathione levels and disrupting redox homeostasis (169). In the present study, 3-oxo-C_{12}-HSL treatment significantly increased the expression of a number of different UPR related genes including *ATF3, DDIT3/CHOP, XBP1* and *HSP*, consistent with previous reports (1). In addition, 3-oxo-C_{12}-HSL treatment negatively impacted host anti-oxidant defences, as evidenced by a significant reduction in glutathione levels and a reduction in cellular metabolism. The RNA-seq transcriptome analysis supported the presence of a weakened oxidative defence in response to 3-oxo-C_{12}-HSL treatment in human respiratory cells. For example, 3-oxo-C_{12}-HSL treatment activated genes encoding glutathione degrading enzymes such as the *CHAC1* gene (171), which is predicted to act downstream of the ATF4-ATF3-CHOP branch of the UPR (170). In addition, the RNA-seq analysis showed that 3-oxo-C_{12}-HSL-exposure increased the expression of the gamma-glutamyltransferase (*GGT*) gene, which normally encodes a glutathione degrading enzyme (172), and significantly downregulated the expression of the *GCLM* gene, which encodes the gamma-glutamylcysteine synthetase enzyme responsible for glutathione synthesis (177). Conversely, 3-oxo-C_{12}-HSL reduced the expression of the *GPX4* gene, whose product potentially protects against lipid peroxidation (178).

The efficacy of using extracellular rhPON2 as a 3-oxo-C_{12}-HSL (QSI)-blocking therapy was determined by investigating its ability to mitigate the 3-oxo-C_{12}-HSL-mediated effects discussed above. On a global scale, the transcriptome analysis, and cytokine release, apoptosis and cell metabolism assays demonstrated that rhPON2 treatment largely blocked the 3-oxo-C_{12}-HSL-mediated effects on airway epithelial cells. Human respiratory epithelial cells treated with both rhPON2 and 3-oxo-C_{12}-HSL compared to controls, had 634 genes differentially expressed, where 566 were downregulated and only 68 genes were upregulated, respectively. In contrast, 949 genes were differentially expressed when cells were exposed to 3-oxo-C_{12}-HSL alone and compared to controls. Comparative to cells treated with rhPON2+3-oxo-C_{12}-HSL, cells treated with rhPON2 alone had 136 genes differentially expressed compared to controls. Importantly, genes which were upregulated following exposure to 3-oxo-C_{12}-HSL and involved in immune responses (IL-17, TNF, NF-κB, and cytokine-cytokine receptor

interactions), apoptosis (FoxO and NF-κB signalling) and cancer-related pathways (TGF-β and MAPK signalling) were significantly downregulated when cells were treated with rhPON2 before exposure. For example, 3-oxo-C_{12}-HSL exposure induced the expression of genes in the MAPK signalling pathway as well as MMP3 gene expression whose products could potentially lead to the degradation of tight junction (TJ) proteins and this induction of gene expression did not occur when cells were treated with rhPON2 before exposure. rhPON2 treatment also mitigated the 3-oxo-C_{12}-HSL-mediated decrease in expression of genes whose proteins are otherwise involved in maintaining tight-junctions and cytoskeleton remodelling (*IQGAP1, Cdc42, Rac1, RhoA,* and *RhoB*). Additionally, rhPON2 blocked the observable detrimental effects of 3-oxo-C_{12}-HSL on cell morphology, such as loss of cell-to-cell contact. Therefore, extracellular rhPON2 treatment is predicted to prevent many of the detrimental effects of 3-oxo-C_{12}-HSL on epithelial barrier integrity. In future experiments, it would be interesting to investigate if rhPON2 could prevent the detrimental effects of 3-oxo-C_{12}-HSL on TER and the paracellular transport of ions, as well.

Strikingly, rhPON2 treatment prior to 3-oxo-C_{12}-HSL exposure mitigated the 3-oxo-C_{12}-HSL-mediated upregulation of several pro-inflammatory genes and significantly diminished IL-6 and IL-8 release. Based on the RNA-seq transcriptome analysis rhPON2 also reduced the expression of genes belonging to pathways thought to be involved in regulating inflammatory gene expression in response to 3-oxo-C_{12}-HSL treatment in human airway epithelial cells, such as the ERK/MAPK kinases, leading to the activation of NF-kB (75) (71) (1), the NF-κB family members REL, NF-κB2 and EGR1 (71), and the unfolded protein response (UPR) (1).

rhPON2 also inhibited the 3-oxo-C_{12}-HSL upregulated expression of genes associated with both the intrinsic (caspases 2 and 9) and extrinsic (*TNFRSF9, caspase 8 AP2* and *caspase 10)* apoptotic pathways (179), as well as, pro-apoptotic genes (*TNFRSF9, BCL2L11, PMAIMP1, BCL2A1* and *BCL2L13*), while preventing 3-oxo-C_{12}-HSL-mediated suppression of anti-apoptotic genes (*BCL2L2* and *BCL7C).* The ability of rhPON2 treatment to protect against these 3-oxo-C_{12}-HSL-mediated changes in gene expression was ultimately demonstrated when cells treated with rhPON2 before exposure to 3-oxo-C_{12}-HSL were protected from induction of caspase 3/7 activity and the associated apoptosis. These data taken together show that 3-oxo-C_{12}-HSL is likely to induce apoptosis in respiratory cells by either upregulating pro-apoptotic pathways, or else by down-regulating anti-apoptotic pathways, and that 3-oxo-C_{12}-HSL's pro-apoptotic effects in cells and its repression of certain anti-apoptotic pathways was essentially ameliorated by exogenously supplied rhPON2.

Overproduction of the UPR associated protein CHOP induces apoptosis via caspase 3 activation (98, 176) and/or depleting cellular glutathione levels and disrupting redox homeostasis (169). Extracellular rhPON2 treatment reduced the 3-oxo-C_{12}-HSL induced upregulation of genes in the UPR (*ATF3, DDIT3/CHOP, XBP1* and *HSP*), indicative of cellular stress and apoptosis. This result is consistent with those of Kim *et al.* (2011) (1) where siRNA silencing of endogenous mammalian PON2 in 3-oxo-C_{12}-HSL-treated HAEC cells lead to the subsequent upregulation of the UPR related *ATF3, XBP1* and *DDIT3/CHOP* genes.

rhPON2 also protected respiratory cells against the pro-oxidative effects of 3-oxo-C_{12}-HSL as treatment with rhPON2 rescued glutathione levels in 3-oxo-C_{12}-HSL-treated cells and counteracted 3-oxo-C_{12}-HSL-mediated UPR-regulation of *CHAC1* and *GGT* and down-regulation of *GCLM* and *GPX4*. This is supported by a report by Devarajan *et al.*(180) demonstrating that murine PON2 KO peritoneal macrophages exposed to 3-oxo-C_{12}-HSL have decreased glutathione levels compared to otherwise wild-type macrophages.

Collectively, these data show for the first time the effectiveness of extracellular rhPON2 as a 3-oxo-C_{12}-HSL-blocking therapy. In the following chapter, a non-isogenic cell line pair (CF and non-CF) and an isogenic cell line pair sufficient and deficient in CFTR are used to further investigate the ability of rhPON2 to block 3-oxo-C_{12}-HSL-mediated effects in cells.

Chapter Four: rhPON2 treatment protects CFTR mutant and CFTR deficient respiratory cells from the detrimental effects of 3-oxo-C_{12}-HSL

4.1 Introduction

Cystic fibrosis is the most common inherited autosomal recessive disorder affecting Caucasian populations and is caused by mutations in the cystic fibrosis transmembrane conductance regulator (*CFTR*) gene. Over 1,900 distinct disease-causing mutations have been identified in the *CFTR* gene ultimately resulting in an almost complete lack of protein, production of dysfunctional CFTR channels, or insufficient production of functional CFTR protein and too few channels (8, 14). The absence of normally functioning CFTR channels or reduced channel numbers in apical membranes of airway epithelial cells leads to the disruption of Cl^- transport; dysregulation of the epithelial sodium channels (ENaC); and eventually to excess Na^+ reabsorption. Consequently, the airways of people with CF accumulate excessive amounts of dehydrated mucus, which diminish the operations of the normal mucociliary clearance apparatus and serve as a favourable environment for microbial colonisation/infection (14) (15). With increasing age, persistent colonisation and infection and eventual chronic infection by *P. aeruginosa* is associated with much of the morbidity and most of the mortality in people with CF (17). This infection and related airway obstruction, induces a pro-inflammatory response (e.g. IL-8, IL-6, TNFα release) resulting in excessive neutrophils and neutrophil product accumulation in the lungs of CF patients. The noxious products released by neutrophils contribute to the lung tissue destruction observed in CF patients (181). In addition, a study by Erickson *et al*. (2002) (45), demonstrated that *P. aeruginosa* quorum sensing circuits are active during infection of the airways of CF patients. They detected mRNA transcripts of several LasI (3-oxo-C_{12}-HSL cognate receptor)-dependent genes and recovered biologically active 3-oxo-C_{12}-HSL (1 – 22 nM) and C_4-HSL (1 – 5 nM) from CF patient sputa using an autoinducer bioassay. Using a more sensitive assay to detect AHLs (UPLC-MS), Charlton and colleagues (48) detected AHL concentrations as high as 600 μM in supernatants from *P. aeruginosa* biofilms grown *in vitro*. Since high level AHL accumulation occurs in *P. aeruginosa* biofilms and AHLs are readily detectable in the airways of people with CF, it is reasonable to suspect that besides being important for bacterial pathogenesis the AHLs might well also be modulating host cell functions and this modulation may differ between cells with fully functional CFTR channels and cells with dysfunctional or insufficient channels.

Previous research, using *in vitro* cell culture, demonstrated that *P. aeruginosa* induces a hyperinflammatory response in CF respiratory cells compared to non-CF cells or CFTR corrected cells (69, 182-184) similar to the pro-inflammatory response observed in the lungs of CF patients. Additionally, Mayer and colleagues (2011) (71) demonstrated a 3-oxo-C_{12}-HSL-induced hyperinflammatory response in CF cells (CuFi-1, IB3-1) compared to non-CF (NuLi-1) and CFTR corrected CF (C38) cells. Together these results suggest that 3-oxo-C_{12}-HSL may contribute to the hyperinflammatory response resulting in lung tissue damage favouring bacterial colonisation and persistence.

CF cells containing the CFTR F508del mutation (the most common CFTR mutation and resulting in a misfolded protein) have additional dysfunction in other cellular pathways and processes such as the unfolded protein response (185, 186), apoptosis (187), and airway epithelial repair (188) pathways and this dysfunction further contributes to the pathogenesis of *P. aeruginosa*. It has also been suggested that reduced levels of CFTR protein in non-CF cells can also increase the pro-inflammatory response (189) (182, 190). Therefore, any therapy targeting the bacterial QS molecule should be investigated using cells with a CFTR mutation and/or a CFTR deficiency since cellular responses to 3-oxo-C_{12}-HSL and rhPON2 treatment may not be accurately predicted from studies using non-CF cells with sufficient functional CFTR.

Research described in previous chapters of this thesis demonstrated that rhPON2 treatment of bacterial cultures reduced *P. aeruginosa* virulence and biofilm formation, and of non-CF human cells protected them from the detrimental 3-oxo-C_{12}-HSL-mediated effects (e.g. inflammation). In this chapter, the ability of rhPON2 to protect cells from adverse 3-oxo-C_{12}-HSL-mediated effects was investigated *in vitro* using two alternative models. The first model involved a non-isogenic but widely used cell pair, NuLi-1 (non-CF, CFTR sufficient) and CuFi-1 (CF, CFTR deficient) cells, and the second an isogenic cell pair, wild-type CFTR sufficient Calu-3 cells compared to Calu-3 cells with reduced CFTR expression.

4.2 Materials and Methods

4.2.1 Reagents, Antibodies and PCR primers

Synthetic 3-oxo-C_{12}-HSL was purchased from Cayman (Ann Abor, Michigan). Antibodies used were specific for the following antigens: human CFTR-C terminus (catalogue no. MAB25031; R &D systems Minneapolis, MN), β-actin (C4, catalogue no. sc47778; Santa

Cruz, Santa Cruz, CA), goat anti-mouse-biotin polyclonal conjugate (catalogue no. AP501B AbDSerotech, Raleigh, NC) and streptavidin-HRP conjugate (catalogue no. 18-152 AbDSerotech). Immobilon Western Chemiluminescent HRP substrate (Millipore, Billerica, MA) was used for detection of proteins for the western and dot blot analysis. The siRNA duplexes and *CFTR* targeted PCR primers were sourced from Qiagen (Valencia, CA). All other PCR primers were purchased from Geneworks (Thebarton SA, AUS, primer sequences are listed in Table 3.1).

4.2.2 Human cell culture lines

The respiratory human cell lines used in this study were Calu-3 (ATCC HTB-55), BEAS-2B (ATCC CRL-9609), NuLi-1 (ATCC CRL-4011) and CuFi-1 (ATCC CRL-4013) purchased from ATCC. The 16HBEσ cell line was a gift from Associate Professor Anthony Kicic, (Telethon Institute for Child Health Research, Perth, WA, Australia). Calu-3, BEAS-2B and 16HBEσ were routinely cultured in Dulbecco's Modified Eagle Medium (DMEM, Life Technologies, Carlsbad, CA) supplemented with 10% (v/v) Australian origin foetal bovine serum (FBS; Bovogen, VIC, Australia), 500 U/mL penicillin (Life Technologies), 500 μg/mL streptomycin (Life Technologies) and 4 mM L-glutamine (Life Technologies). The culture dishes or plates were coated with media consisting of 0.001 mg/mL bovine plasma fibronectin (Life Technologies), 0.03 mg/mL bovine collagen type-I (Life Technologies), 0.01 mg/mL bovine serum albumin (BSA) and Cohn Fraction V (Sigma, St. Louis, MO) made in Dulbecco's phosphate buffered saline (DPBS; Life Technologies) prior to use. NuLi-1 and CuFi-1 cells were cultured in serum free bronchial epithelial cell growth medium (BEGM; Lonza, Walkersville, MD) and supplemented according to manufacturer's instructions with provided growth factors, cytokines and 500 U/mL penicillin (Life Technologies) and 500 μg/mL streptomycin (Life Technologies). The culture dishes or plates for NuLi-1 and CuFi-1 cells were coated with 60 μg/mL human placental collagen Type IV (Sigma) made up in DPBS according to ATCC guidelines prior to use.

4.2.3 Optimising cell lysis buffer for CFTR protein extraction

Total protein was extracted from Calu-3 cells using 1% SDS, 1% NP-40, or 1% Triton-X 100 in 50 mM Tris-HCl (pH 7.5), 138 mM NaCl, 5 mM EDTA and EDTA-free protease inhibitor cocktail (Roche, Basel, Switzerland). Lysates were sonicated using a Microson™ Misonix XL sonicator (Misonix, NY, USA), centrifuged at 12,000 rpm for 20 minutes and supernatants collected and stored at -80 °C. The samples lysed with 1% SDS were boiled for 5 minutes,

while those lysed with 1% NP-40, or 1% triton X-100, were heated at 37 °C for 20 minutes and a 10 μl aliquot of each sample was spotted onto nitrocellulose membrane and allowed to dry. The membranes were blocked with 5% skim milk containing 0.1% PBST for one hour and incubated with the primary antibody (CFTR-C 1:1,000 in 5% skim milk in TBST) overnight. The next day, membranes were incubated with a biotin conjugated secondary antibody (goat anti-mouse IgG/A/M:biotin 1:5000 in 5% skim milk in TBST) for one hour at room temperature, washed several times with PBST and incubated with streptavidin-HRP in 5% skim milk for one hour at room temperature and again washed several times with PBST. Dot blots were developed using Immobilon Western Chemiluminescent HRP substrate and visualised using the Carestream Image Station 2000 (Carestream Molecular Imaging; Rochester, NY).

4.2.4 Total Protein Extraction and western analysis

Total protein was extracted from 5 x 10^5 cells lysed in buffer containing 1% NP-40 in 138 mM NaCl, 5 mM EDTA, EDTA-free protease inhibitor cocktail (Roche) and 50 mM Tris-HCl (pH 7.5), and the samples sonicated and supernatants stored as described above. Protein concentrations were determined using the EZQ protein assay kit (Invitrogen, Carlsbad, CA). Extracted protein (40 μg) was denatured in Novex LDS sample buffer (Life Technologies) and Novex reducing agent (Life Technologies) at 37 °C for 20 minutes. Proteins were separated using 4–12% PAGE (Life Technologies) and transferred to a nitrocellulose membrane (Life Technologies). The CFTR protein was detected using the anti-CFTR-C and anti-β-actin (Santa Cruz, USA) antibodies and visualised as described above.

4.2.5 siRNA knock-down of CFTR expression in vitro

Calu-3 cells used in siRNA-knockdown experiments were cultured in 12-well plates to a density of 5 x 10^5 cells per well. Cells were transfected with HiPerfect in 10% FBS MEM with either 5-50 nM of negative control siRNA (neg-siRNA, catalogue no 301799, Qiagen), or siRNA targeting the human *CFTR* gene (CFTR-1 siRNA and CFTR-4 siRNA, catalogue no 1027416, Qiagen) for three days according to the manufacturers instruction (Qiagen). The transfection efficiency was quantified using cell death control siRNA (cell death siRNA, catalogue no 301799, Qiagen).

4.2.6 Treatment of *CFTR* deficient cells with rhPON2 and 3-oxo-C_{12}-HSL

Calu-3 wild-type and Calu-3 CFTR deficient cells were treated with vehicle control (0.1% DMSO, 1% Buffer E in 10% FBS MEM media), 5 U rhPON2 (in vehicle) ten minutes prior to the addition of 50 μM 3-oxo-C_{12}-HSL (in vehicle) then incubated for six hours at 37 °C with 5% CO_2. After six hours, RNA was extracted from the cells and used for gene expression analysis by RT-qPCR (see sections 3.2.4, and 3.2.5).

4.3 Results

4.3.1 rhPON2 protects CuFi-1 cells from 3-oxo-C_{12}-HSL-induced stress

Results described in chapter 3 demonstrated the magnitude of 3-oxo-C_{12}-HSL-mediated gene expression modulation in host cells and the ability of rhPON2 treatment to mitigate these effects in cells without a *CFTR* mutation (NuLi-1). It is well-established that the expression levels of multiple cellular pathways are dysregulated in cells harbouring a *CFTR* mutation (71, 173, 185). Thus, cellular responses to 3-oxo-C_{12}-HSL and rhPON2 treatment may not be accurately predicted from studies using cells with sufficient and functional CFTR. CuFi-1 cells are a continuous culture human airway epithelial cell originally isolated from an individual with CF (*CFTR*$^{-/-}$, homozygous F508del), and are often used in comparative studies with NuLi-1 cells (*CFTR*$^{+/+}$), which are from a non-CF individual but have been similarly transformed. In addition, both cell lines have ion channel physiology as expected of their genotype (156).

NuLi-1 (non-CF) and CuFi-1 (CF) cells were treated with 50 μM 3-oxo-C_{12}-HSL in the presence and absence of 5U rhPON2 or rhPON2 alone for two hours, and the expression of several genes, chosen based on RNA-seq data analysis (chapter 3) and involved in pathways regulating inflammation, UPR and cellular stress, was investigated using RT-qPCR analysis. The basal level of expression of *TNFα, IL-6, IL-8, XBP-1* and *ATF3* were significantly higher in CuFi-1 (CF) cells compared to NuLi-1 (non-CF) cells (Figures 4.1), consistent with the multiple reports of upregulation of cellular stress pathways in CF cells (71, 173, 185). Treatment of CuFi-1 (CF) cells with rhPON2 alone significantly reduced the expression of most of these genes, with the exception of *XBP-1* and *ATF3*, to levels comparable to basal levels measured in non-treated NuLi-1 (non-CF) cells, while having little effect on the level of expression of these genes in the NuLi-1 cells. These results demonstrated that treatment of CuFi-1 cells with rhPON2 alone dampened the expression of genes with known roles in

promoting cellular stress and pathways usually reported to be upregulated in CF cells harbouring the F508del CFTR mutation (71, 173, 185).

When CuFi-1 (CF) and NuLi-1 cells were exposed to 3-oxo-C_{12}-HSL, expression of all genes investigated was significantly upregulated, compared to non-treated controls. The response of CuFi-1 cells to 3-oxo-C_{12}-HSL treatment was generally exaggerated as compared to the response in the NuLi-1 cells, with the exception of the *CHAC1* and *HSPA1* genes, indicative of a greater sensitivity of CFTR-defective cells to 3-oxo-C_{12}-HSL. Importantly, rhPON2 application diminished 3-oxo-C_{12}-HSL-mediated induction of all genes assessed (the UPR genes *ATF3*, *XBP-1*, *HSPA1A* and *CHAC1* and inflammatory genes *IL-6*, *IL-8* and *TNF*α) in both the CuFi-1 and NuLi-1 cells.

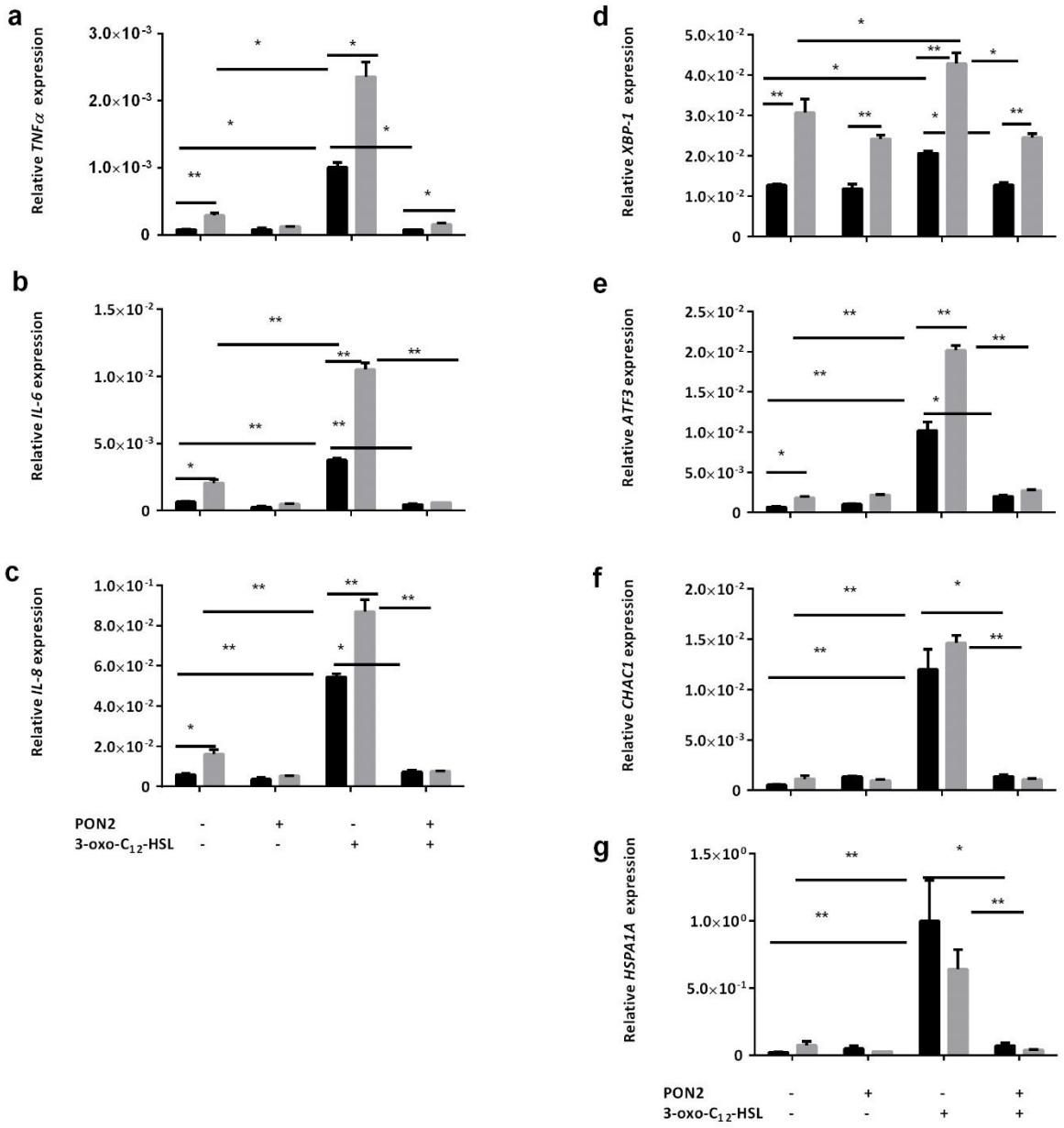

Figure 4.1. rhPON2 mitigates the effects of 3-oxo-C_{12}-HSL in cells with and without a *CFTR* mutation.

NuLi-1 (non-CF, black bars) and CuFi-1 (CF, grey bars) cells were treated with vehicle control (0.1% DMSO, 1% Buffer E in BGEM media), 5 U rhPON2 (in vehicle) ten minutes prior to the addition of 50 μM 3-oxo-C_{12}-HSL (in vehicle) then incubated for two hours at 37 °C with 5% CO_2. RNA was isolated and expression of the inflammatory genes *TNF*α (a) *IL-6* (b) *IL-8* (c), and UPR associated genes (d) *XBP-1* (e) *ATF3* (f) *CHAC1,* and (g) *HSPA1A* were assessed by RT-qPCR and normalised to their respective control. Errors bars indicate ± SEM of $n = 3$, * $P \leq 0.05$, ** $P \leq 0.01$ (Student's two-tailed t-test).

4.3.2 Optimisation of cell lysis buffer for CFTR protein extraction

Although CuFi-1 and NuLi-1 cells are frequently used as a matched CF and non-CF pair, they are not isogenic. Furthermore, it has also been suggested that reduced CFTR expression in non-CF cells can also result in an increase in the pro-inflammatory response (189-191). In order to further support the potential of rhPON2 to mitigate the effects of 3-oxo-C_{12}-HSL in the presence of insufficient CFTR, an isogenic cell line was developed. To inform this development, first the cell lysis conditions were optimised for extraction of CFTR protein, and second the level of CFTR protein expression was measured in all respiratory epithelial cell lines available in our laboratory.

To optimise CFTR protein extraction, Calu-3 cells were lysed using a range of different lysis buffers. Given the CFTR protein being a transmembrane glycoprotein that is expressed at the apical membrane of epithelial cells, the detergent component of the lysis buffer was modified to contain either 10% SDS, 1% Triton X-100, or else 1%NP-40. Following cell lysis, protein extracts were analysed by dot blots and CFTR detected using an anti-CFTR antibody (Figure 4.2**)**. CFTR was detectable following cell lysis with buffer containing either SDS or NP-40, with more CFTR protein being recovered with the NP-40 containing lysis buffer. In contrast, little CFTR was detectable in lysates prepared from cells lysed with a buffer containing Triton-X 100. Therefore, the NP-40 buffer was used in all future experiments to lyse cells.

Figure 4.2. Detection of CFTR in cell lysates.

Calu-3 cells were lysed in 10% SDS, 1% triton X-100 and 1% NP-40. Following cell lysis, protein extracts were analysed by dot blots, and CFTR detected using an anti-CFTR antibody.

4.3.3 Calu-3 cells have the highest level of *CFTR* gene and CFTR protein expression of all cells investigated

The level of *CFTR* gene and CFTR protein expression was investigated in a number of airway cell lines available in our laboratory to determine the most appropriate cell line to use as the wild-type cell before *CFTR* knock-down. *CFTR* gene expression (assessed by RT-qPCR) and CFTR protein levels (assessed by western analysis) varied greatly between the epithelial cell lines examined (Figure 4.3a and b**)**. Calu-3 cells had the highest level of *CFTR* gene expression of all cell lines tested (Figure 4.3a). In comparison, there was only low level *CFTR* expression in BEAS-2B, NuLi-1, and CuFi-1 cells.

CFTR protein synthesis occurs in the ER before protein trafficking to the golgi apparatus, where it undergoes post-translational modifications, a process that ultimately, depending on the efficiency of each step, results in three different CFTR protein forms; the non-glycosylated form (known as band A, ~130kDa), the ER core-glycosylated form (known as band B, ~150 kDa) and the fully-glycosylated mature form (known as band C, ~170-180 kDa (192). All three forms of CFTR protein were detected in Calu-3 (non-CF) cell lysates and also the 16HBEσ cells, albeit at lower levels (Figure 4.3b). There was no detectable mature fully-glycosylated CFTR (band C) in lysates prepared from either the non-CF NuLi-1 or BEAS-2B cells, suggesting only low-level expression of CFTR by these cells, a result that is supported by the low level of *CFTR* gene expression. CuFi-1 cells were originally isolated from an individual with CF (delta F508/delta F508) where much of the CFTR protein would be misfolded and degraded before trafficking to the golgi for glycosylation and as such it was unsurprising that there was no detection of either core glycosylated (band B) or fully-glycosylated (band C) mature CFTR detected in CuFi-1 cell lysates. On the basis that Calu-3 cells expressed the highest level of detectable fully-glycosylated mature CFTR (band C), of all cell lines examined, Calu-3 cells were chosen to be the wild-type line in subsequent CFTR-knockdown studies.

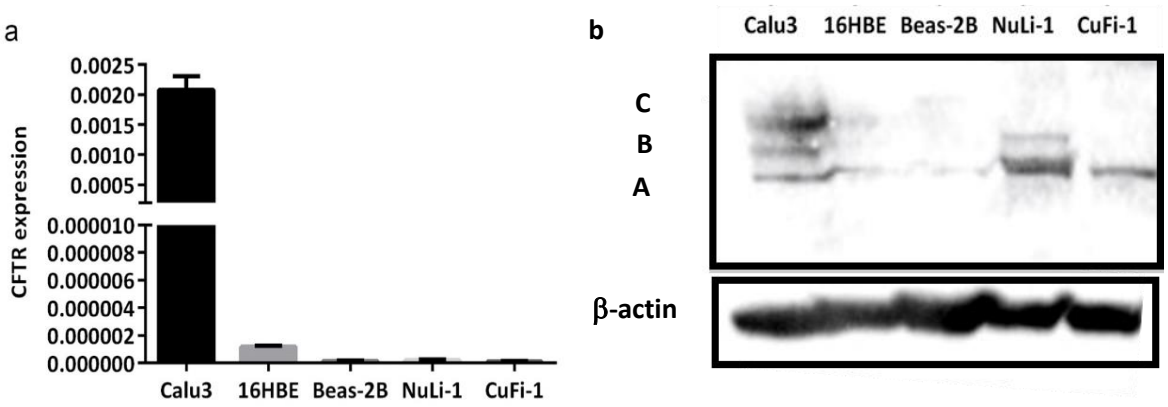

Figure 4.3. Expression of CFTR by respiratory epithelial cell lines.

Human respiratory epithelial cell lines Calu-3, 16HBEσ, BEAS-2B, NuLi-1 (non-CF) and CuFi-1 (CF) were cultured for three days and a) RNA isolated, and *CFTR* gene expression assessed by RT-qPCR (relative to *ACTB*) or b) membrane proteins extracted with buffer containing 1% NP-40, 70 μg protein separated by SDS-PAGE, and CFTR protein level assessed using western analysis and an anti-CFTR antibody. Error bars represent ± SEM of n=3.

4.3.4 Knock-down of CFTR expression in Calu-3 cells

To determine the siRNAs transfection efficiency in Calu-3 cells, cells were transfected with either neg-siRNA, cell death siRNA, CFTR-1 siRNA, or CFTR-4 siRNA. The cell death siRNA control contains a mixture of siRNAs that target and knock-down the expression of genes essential for cell survival and is commonly used to determine transfection efficiency. In this study, transfection with the cell death control siRNA resulted in approximately 75% cell death (Figure 4.4 d), suggestive of approximately 75% transfection efficiency in these cells. No cell death was observed when cells were transfected with neg-siRNA, or any of the CFTR siRNAs (Figure 4.4a-c).

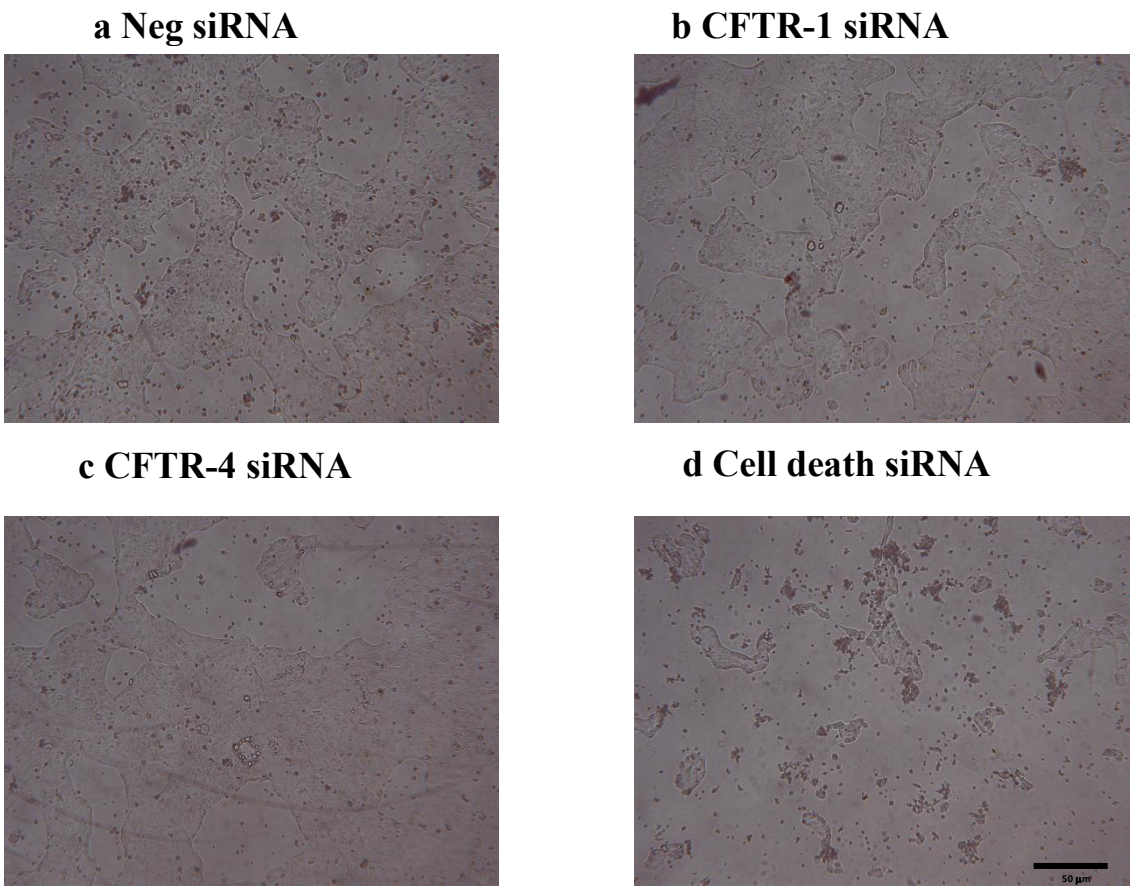

Figure 4.4. Transfection of Calu-3 cells.

Calu-3 cells (triplicate wells) were transfected with (a) neg-siRNA, (b) CFTR-1 siRNA, (c) CFTR-4siRNA or (d) cell death siRNA and incubated for three days. Cells from each transfection were visualised using a Leica DM IL light microscope at a magnification of × 200. Representative images were captured and acquired using a Leica DFC320 digital camera and Leica Firecam v3.4.1 software.

In order to optimise the concentration of siRNA to use in experiments for maximal CFTR knock-down, Calu-3 cells were transfected with one of four different concentrations (5, 10, 20 or 50 nmol) of CFTR-4 siRNA and incubated for three days. *CFTR* gene expression was significantly decreased by approximately 50% (Figure 4.5a), irrespective of the concentration of siRNA used. In a further attempt to increase the percentage of CFTR knock-down in the Calu-3 cells, an alternative CFTR siRNA (CFTR-1 siRNA) was transfected into these cells, however, no further reduction in *CFTR* gene expression (Figure 4.5b), or CFTR protein (Figure 4.5c) production (all 3 forms) was achieved. In all subsequent CFTR knockdown experiments, 10 nM of CFTR-4 siRNA was used.

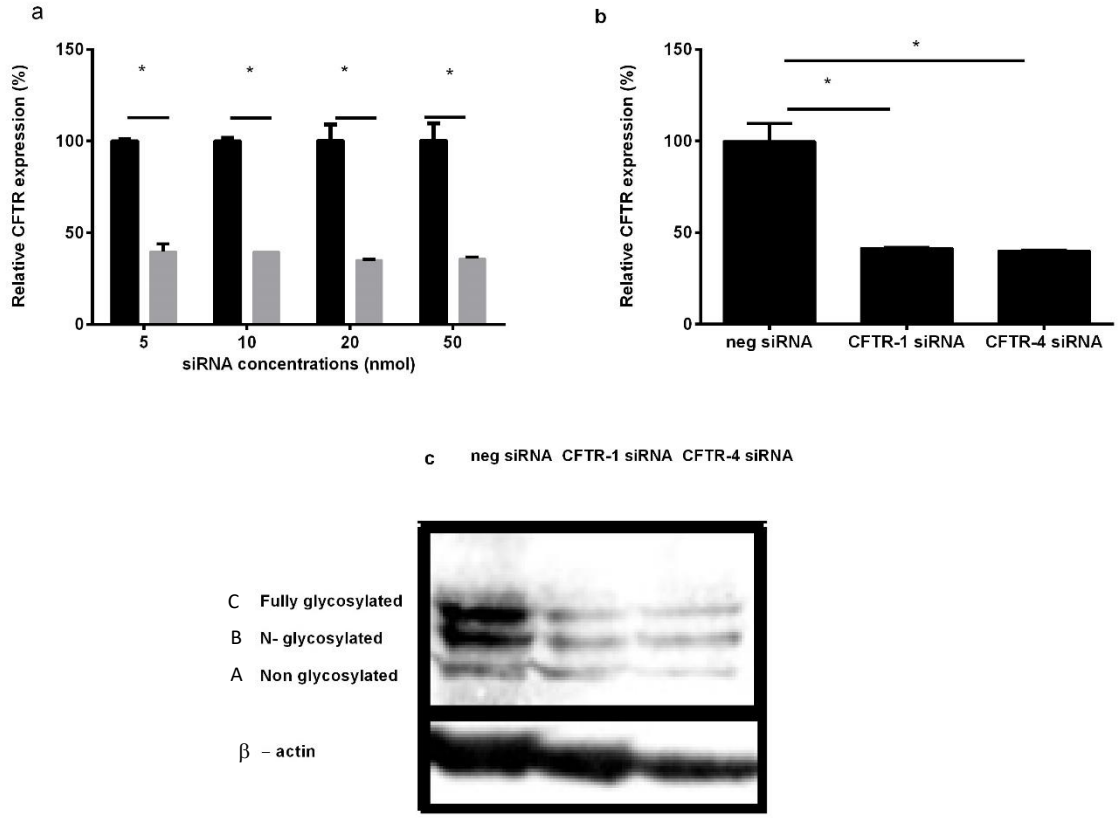

Figure 4.5. CFTR knock-down by siRNA decreases CFTR gene and CFTR protein expression

Calu-3 cells were transfected with either neg-siRNA or (a) CFTR-4 siRNA (5, 10, 20 or 50 nmol) or (b, c) 10 nmol CFTR-1 or -4 and cultured for three days. (a, b) RNA was isolated and *CFTR* gene expression assessed using RT-qPCR (relative to *ACTB*) or (c) CFTR protein expression analysed by western blot and using an anti-CFTR antibody. Results represent means (relative to neg-siRNA transfected cells) ± SEM of $n = 3$, *, $P \leq 0.05$ (Student's two tailed t-test).

4.3.5 rhPON2 treatment protects cells with reduced levels of CFTR from 3-oxo-C_{12}-HSL-induced upregulation of inflammatory gene expression

To demonstrate the ability of rhPON2 to diminish 3-oxo-C_{12}-HSL-mediated gene regulation (as described in Chapter 3) in isogenic cells with sufficient ($CFTR^{+/+}$) and insufficient CFTR (CFTR-knockdown), cells were treated with vehicle control (0.1% DMSO, 1% Buffer E in 10% FBS MEM media), 5 U rhPON2 (in vehicle) ten minutes prior to the addition of 50 μM 3-oxo-C_{12}-HSL (in vehicle) then incubated for six hours at 37 °C with 5% CO_2.Gene expression in these cells was assessed by RT-qPCR.

The response of both wild-type and *CFTR*-knockdown Calu-3 cells (~50% decreased *CFTR* expression, Figure 4.6a) to 3-oxo-C_{12}-HSL was comparable and resulted in significantly increased expression of the inflammatory genes *TNFα, IL-6* and *IL-8* (Figures 4.6 b, c, d, respectively) compared to controls. This differs to the response of CuFi-1 (CF) cells when exposed to 3-oxo-C_{12}-HSL compared to the response of the non-isogenic NuLi-1 (non-CF) cells (Figure 4.1), in that the CuFi-1 (CF) cells had an exaggerated inflammatory and UPR response. In contrast, 3-oxo-C_{12}-HSL treatment of Calu-3 cells (wild type and CFTR knockdown) did not significantly alter the expression of the UPR associated genes *CHAC1*, *AFT3* and *HSPA1A* (Figures 4.6 e, f, g**,** respectively) compared to both the NuLi-1 and CuFi-1 cells.

Treatment of both wild-type and *CFTR* knock-down Calu-3 cells with rhPON2+ 3-oxo-C_{12}-HSL prevented the 3-oxo-C_{12}-HSL-mediated upregulation of inflammatory gene expression, *TNFα, IL-6* and *IL-8* (Figures 4.6 b, c, d, respectively) compared to controls, and this response was independent of the level of *CFTR* expression.

An interesting finding in this study is that 3-oxo-C_{12}-HSL treatment reduced *CFTR* mRNA expression in the control Calu-3 cells similar to levels in the CFTR knock-down Calu-3 cells (Figure 4.6a). Furthermore, rhPON2 treatment prevented the 3-oxo-C_{12}-HSL reduced expression of CFTR.

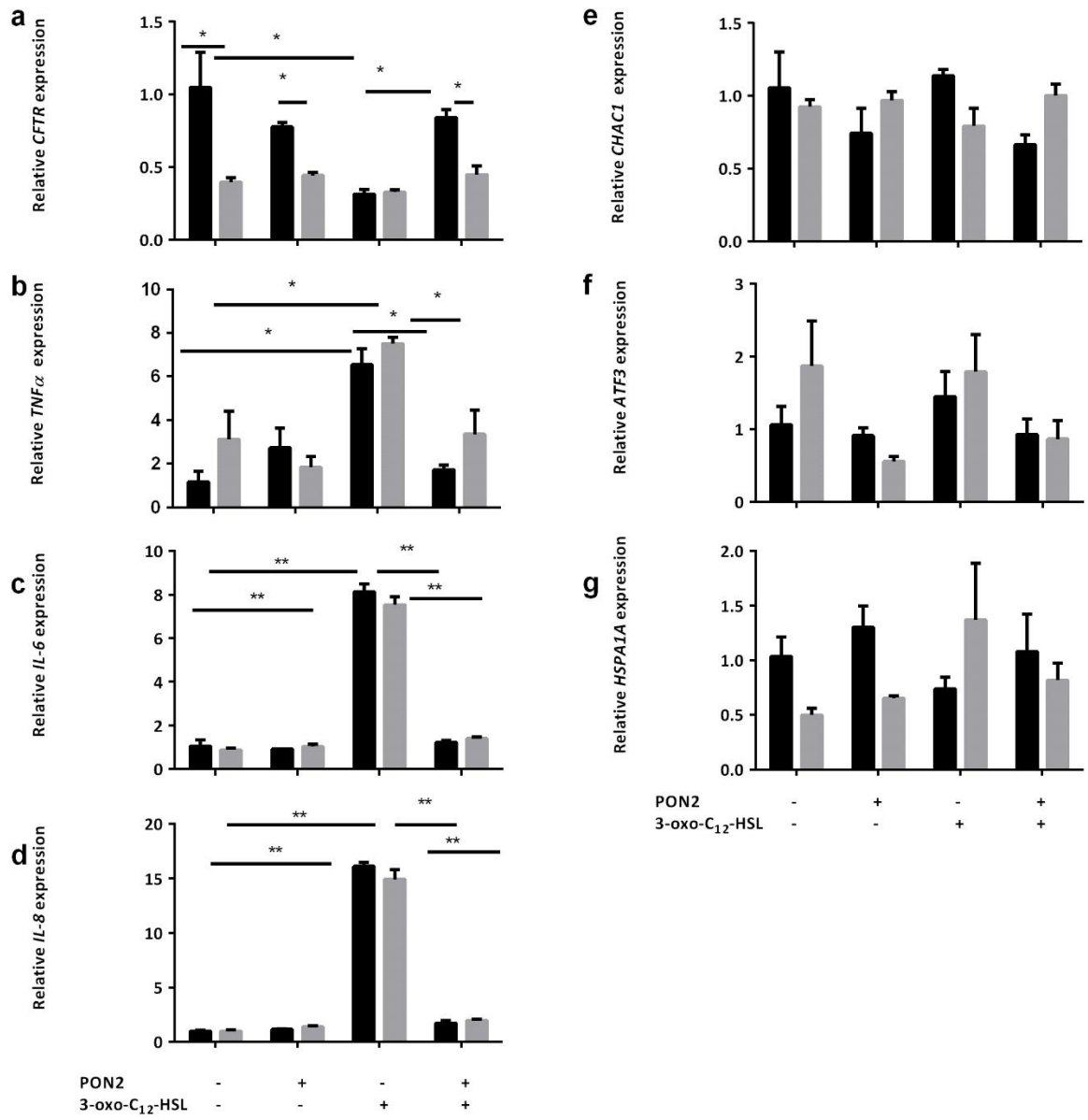

Figure 4.6. rhPON2 treatment prevents 3-oxo-C_{12}-HSL-induced inflammatory responses in both wild-type and *CFTR* knock-down Calu-3 cells.

Calu-3 cells were transfected with neg-siRNA (black bars) or CFTR-4 siRNA (grey bars) and cultured for three days. Cells were treated with vehicle control (0.1% DMSO, 1% Buffer E in 10% FBS MEM media), 5 U rhPON2 (in vehicle) ten minutes prior to the addition of 50 μM 3-oxo-C_{12}-HSL (in vehicle) then incubated for six hours at 37 °C with 5% CO_2. RNA was isolated, and the expression of *CFTR* (a), inflammatory genes (b) *TNFα,* (c) *IL-6,* (d) *IL-8* and UPR associated genes (e) *CHAC-1,* (f) *ATF3* and (g) *HSPA1A* was assessed by RT-qPCR and

normalised to their respective controls. Errors bars indicate ± SEM of $n = 3$, * $P \leq 0.05$, ** $P \leq 0.01$ (Student's two-tailed t-test).

4.4 Discussion

In this chapter, the ability of rhPON2 to protect cells from the detrimental effects of 3-oxo-C_{12}-HSL was investigated using two alternative models to compare cells with dysfunctional or deficient CFTR to cells with functional CFTR. The first model used a non-isogenic but widely used cell pair, the NuLi-1 (non-CF) and CuFi-1 (CF) cells. The second and alternative isogenic model used wild-type Calu-3 cells compared to Calu-3 cells with a reduced CFTR expression.

The basal level of expression of *TNFα*, *IL-6* and *IL-8* genes was higher in CF (CuFi-1 containing CFTR F508del/F508del mutation) compared to the non-CF (NuLi-1) cells, and the expression of these genes was further increased when CuFi-1 cells were treated with 3-oxo-C_{12}-HSL compared to similarly treated NuLi-1 cells. These results are similar to those reported by Mayer *et al.* (2011) who demonstrated that the inflammatory response is intrinsically upregulated in CF cells carrying the F508del/F508del mutation (e.g. like CuFi-1) and could be further upregulated by exposure to 3-oxo-C_{12}-HSL. The precise mechanism(s) for this hyperinflammatory response observed in CuFi-1 (CF cells) compared to NuLi-1 (non-CF) cells is not known but several hypotheses exist: (i) CF cells homozygous for F508del have less extracellular glutathione, accumulate higher levels of reactive oxygen species and this in turn stimulates the hyperactivation of the MAPKs leading to an increased release of pro-inflammatory cytokines such as IL-6 (193) and (ii) The CFTR F508del mutation produces a misfolded CFTR protein, which activates the UPR and induces a hyperinflammatory response (185, 194). Knorre and colleagues (2002) (195) indeed demonstrated that misfolded F508del-CFTR causes ER stress, constitutive activation of NF-κB and transcription of certain pro-inflammatory genes. In support of this, Vij and colleagues (2006) (173) demonstrated that prevention of UPR activation in CF bronchial cells expressing misfolded (F508del) CFTR, by inhibition of CHOP and proteasome degradation, synergistically repressed NF-κB-mediated IL-8 activation.

Consistent with other studies reporting that F508del CFTR mutation activates the UPR and increases pro-inflammatory responses, results reported in this chapter demonstrates that the basal level of expression of UPR associated genes (*ATF3* and *XBP1*) is higher in CuFi-1 (CF) cells compared to NuLi-1 (non-CF) cells and that the cellular response to 3-oxo-C_{12}-HSL exposure is exaggerated in the CuFi-1 compared to the NuLi-1 cells. Importantly, treatment of

CuFi-1 cells with rhPON2 corrected the high basal expression level of inflammatory and stress response genes (compared to NuLi-1 cells) and when exposed to 3-oxo-C_{12}-HSL prevented exaggerated inflammatory and stress responses. These results lend further support to the view that basal expression levels of inflammatory responses are dysregulated and exaggerated in CF cells harbouring the CFTR F508del mutation, and more broadly in the associated CF airway. However, these cell lines are derived from different donors and have genetic differences other than CFTR (196). Therefore, basal inflammatory levels as well as the potential anti-inflammatory effects of rhPON2 were also investigated in an alternative model where *CFTR* expression was knocked-down in a human non-CF cell line generating a cell culture pair in an identical genetic background with the only difference being the level of CFTR expression.

Calu-3 cells were chosen for CFTR knockdown studies because they expressed the highest level of *CFTR*, as well as the highest level of mature and fully-glycosylated CFTR protein of all the cell lines investigated in the present study. *CFTR* gene expression was knocked-down by 50%, and consequently CFTR protein levels were also reduced by approximately 50% (of note there was ~50% less mature fully glycosylated CFTR produced). Using this model, there was no elevated basal level of inflammatory gene expression (*TNFα*, *IL-8* or *IL-6*) compared to the Calu-3 wild-type cells. Neither was there an exaggerated inflammatory response following exposure to 3-oxo-C_{12}-HSL in the CFTR deficient cells compared to the CFTR sufficient cells. In contrast, a previous study demonstrated increased IL-8 and IL-6 release by Calu-3 cells with a CFTR knock-down compared to control cells (190). The discrepancy in these results may be explained by the different knock-down technologies used resulting in a transient 50% knock-down in this study using siRNA technology compared to a stable 95% knock-down in the Morin study using short hairpin RNA (shCFTR). In particular, in the current study, the transfection efficacy of the siRNA was approximately 70-80%, meaning that a reasonable number of cells were included in the study that may have had near wild-type levels of CFTR expression, whereas in the Morin study it is expected that the stably transfected cells all had severely decreased *CFTR* expression. This technology delivers the shRNA via plasmid or viral vectors allowing for stable integration of shRNA into the DNA and resulting in long-term knock-down of the target gene (197). Taken together, these results suggest that severe (~95%) CFTR deficiency may trigger inflammation whereas a less severe reduction (~50%, similar to a *CFTR* carrier level) does not. This is reminiscent of a study by Gan and colleagues (1995) (198), who demonstrated that patients with the Class V mutation A455E, which results

in reduced levels of functional CFTR, had less frequent colonisation of *P. aeruginosa* and lung disease compared to patients with the Class II mutation F508del.

Interestingly, 3-oxo-C_{12}-HSL treatment reduced *CFTR* mRNA expression in the wild-type Calu-3 cells. This finding is in agreement with a recent study by Ali (149), where it was demonstrated using microarray analysis that 10 μM 3-oxo-C_{12}-HSL also reduced *CFTR* gene expression in wild-type BEAS-2B cells. Additionally, it has been demonstrated that exo-products from *P. aeruginosa* (such as CIF) can reduce *CFTR* mRNA expression, as well as the amount of CFTR rescued at the apical membrane in CF cells containing the F508del CFTR mutation by the CFTR corrector, 4-cyclohexyloxy-2-(1-[4-(4-methoxy-benzenesulfonyl)-piperazin-1-yl]-ethyl)-quinazoline (VRT-325) (199).

Importantly, rhPON2 prevented 3-oxo-C_{12}-HSL-induced inflammatory gene expression and 3-oxo-C_{12}-HSL-induced down-regulation of *CFTR* gene expression. These results could have implications for CFTR corrector therapy as continued suppression of *CFTR* gene expression by *P. aeruginosa* would decrease the efficacy of therapies targeting correction of CFTR protein folding and function.

Collectively, these data show for the first time the effectiveness of extracellular rhPON2 as a 3-oxo-C_{12}-HSL-blocking therapy in CF cells harbouring a CFTR-F508del mutation and in cells with functional but deficient levels of CFTR protein.

Chapter Five: Development of an acute *P. aeruginosa* pulmonary infection model to test rhPON2 as an anti-inflammatory therapy.

5.1 Introduction

The *in vitro* studies used in the present study demonstrated that a stable extracellular rhPON2 could hydrolyse the lactone ring of 3-oxo-C_{12}-HSL, and thereby strongly reduce the expression of key *P. aeruginosa* virulence and biofilm-related genes and biofilm formation, as well as ameliorate several of its associated detrimental effects on non-CF and CF host cells. Collectively, these results strongly suggest that extracellularly administered rhPON2 could be a potentially useful potent QS-inhibitor that might find some novel and important uses in treating *P. aeruginosa* infections.

Having demonstrated proof-of-principle for stable extracellular rhPON2 in our laboratory's *in vitro* experiments, it was necessary to test its potential effectiveness in preventing/mitigating *P. aeruginosa* infections and related host cell function dysregulation in a host animal model. There are several well-established animal models used to investigate the pathophysiology of *P. aeruginosa* infections, including mice, rodents, guinea pigs, pigs, ferrets and cats (reviewed in (200)). Using mouse models for following *P. aeruginosa* infections, in particular, has several experimental advantages such as relatively low cost, high litter numbers and rapid animal development and maturation, and shorter gestation time compared to other animal models.

Acute or chronic lung *P. aeruginosa* lung infections in mice can be initiated either by aerosolisation (201), intranasal instillation (202), or else intratracheal intubation (203). Normally in an acute infection mouse model, bacteria are delivered in planktonic suspension, and can either be rapidly cleared by the mouse within 24 to 48 hours (204, 205), or else progress to infection and disease. In this context, the outcome of infection can vary and seems to be dependent on the infective bacterial dose, the frequency of inoculation, and on the strain of bacteria and mouse. For example, swiss (SWR/J) mice intratracheally infected with *P. aeruginosa* at a dose of 1×10^7 CFU led to the establishment of a successful acute lung infection, whereas infection with a dose of 2×10^7 CFU proved lethal and resulted in sepsis and eventually death of the animals within 48 hours (206). In contrast to acute *P. aeruginosa* lung infection murine models, which seem to more closely reflect human acute lung infection pathology, chronic *P. aeruginosa* infection mouse models only in-part reflect human chronic lung infections (e.g. in bacterial persistence and lung pathology). To establish a chronic bacterial lung infection (more than one month), bacterial cells are usually embedded in agarose,

agar or seaweed alginate, to mimic artificial bacterial biofilms (207) before installation in the mouse lung. A chronic infection model seems particularly well suited for experiments aimed at identifying novel molecular targets involved in maintaining chronicity of infections, or developing new therapies to target established bacterial biofilms. Alternatively, an acute lung infection mouse model seems more suited to testing potentially useful preventative therapeutic approached.

Establishment of an acute *P. aeruginosa* lung infection seems to depend on some of its intrinsic cellular components such as pili (208), flagella (209), and LPS (210) involved in attachment to the host, as well as certain secreted virulence factors such as proteases (elastase and alkaline) (211) and toxins (212, 213). As described earlier, a functioning QS system to regulate bacterial biofilm formation and production of extracellular virulence factors is important for the establishment of lung infection and disease by *P. aeruginosa* (214). Using an acute neonatal mouse infection model, Pearson and colleagues (2000) (214), demonstrated that mice intranasally infected with *P. aeruginosa* stain PAO1 defective in Δ*lasI*, Δ*lasR*, or else both Δ*lasIR* developed less of the symptoms and signs of pneumonia and bacteraemia, and hence survived for longer compared to mice that had been infected with otherwise wild-type *P. aeruginosa* cells. Similarly, Rumbaugh and colleagues (1999) (215) showed that QS-defective *P. aeruginosa* cells were less virulent in a mouse burn wound model than wild-type bacterial cells.

Various experimental parameters are used to assess the establishment of an acute pulmonary murine infection, including markers such as increased release of pro-inflammatory cytokine such as TNF-α, IL-6, and IL-8, as well as the progressive induction of an anti-inflammatory response characterised by increased release of cytokines such as IL-10 and IL-4 (216). In a study by Wolbeling and colleagues (2011) (216), C57BL/6J mice were infected intra-tracheally with a sub-lethal dose of 6×10^5 CFU *P. aeruginosa*, and bacterial load and host inflammatory responses and lung function were assessed. These authors found that the mouse lung function declined between six and ten hours post-infection with otherwise wild-type *P. aeruginosa* cells, and it took on average three days for lung function to recover to control levels. The decreased lung function observed in the mice seemed to correlate with an increase in bacterial cell numbers, and host early pro-inflammatory responses (e.g. based on levels of IL-6 and TNF-α over a two-twelve-hour period post-infection) and late anti-inflammatory responses (e.g. based on levels of IL-10 and IL-4 over a 24-hour period post-infection).

It is noteworthy that the strain of mouse used to establish an acute lung infection can significantly influence experimental outcomes. Researchers have demonstrated that C57BL/6J strains are more susceptible to *P. aeruginosa* lung infections compared to BALB/c and DBA/2 (217-219), for example. *P. aeruginosa* infection of C57BL/6J murine lungs resulted in a predominately neutrophilic inflammatory response and extensive tissue damage similar to that observed in CF patients but unlike the response in BALB/c mice (219). Interestingly, a review of the literature describing strain and organ specific responses to fibrotic injury, for example, lung injury in different inbred mouse strains found that C57BL/6J mice are more susceptible to pulmonary fibrosis compared to BALB/c mice (220).

In this present study, an acute lung infection mouse model involving delivery of a sub-lethal dose of *P. aeruginosa* strain PAO1 in C57BL/6J mice strain was optimised in our laboratory and was used to investigate whether extracellular rhPON2 treatment could prevent or reduce infection by *P. aeruginosa* and infection-mediated inflammation.

5.2 Materials and Methods

5.2.1 Ethics statement

Animal experiments were approved by the University of Tasmania Animal Ethics Committee (A0013744) and complied with the Prevention of Cruelty to Animals Act (1986) and the National Health and Medical Research Council (NHMRC) Australian Code of Practice for the Care and Use of Animals for Scientific Purposes 2004.

5.2.2 Bacterial culture conditions

P. aeruginosa strain PAO1 (ATCC 15692) was grown in LB media with shaking (150 rpm) at 37 °C overnight to stationary-phase (OD A_{600} nm of 1–2, representing approximately 5 x 10^9 CFU/ml). For mouse infections, PAO1 was briefly washed in PBS and resuspended at a density of approximately 5 x 10^6 CFU in PBS. Final bacterial load was determined by plate-counting of bacterial numbers in the final inoculum (as described in section 5.3.1).

5.2.3 Mouse Strain used in infection studies

Pathogen-free C57BL/6J male mice (8-12 weeks of age) were purchased from the UTAS breeding colony (Cambridge, Tasmania) and acclimatized for one week in the animal house (Medical Science Building, Hobart, Australia) under constant temperature and light/dark conditions *ad libitum* before use. Each group consisted of at least eight mice, a group size

consistent with appropriate statistical analysis of murine lung gene expression and inflammation (221).

5.2.4 Intranasal infection of mice

Mice were anaesthetised with a mixture of O_2 and isofluorane, and a 20 μl drop of a bacterial suspension (approximately 5 x 10^6 CFU *P. aeruginosa* strain PAO1 with 5 U rhPON2) or 5U rhPON2 alone was applied to their nares. The animals were subsequently observed to ensure that the 20 μl mix was reflexively inhaled (222). Mice were euthanised 12 hours later by CO_2 asphyxiation. Their lungs and tissues were harvested and stored in RNAlater® (Life Technologies, Carlsbad CA) first at 4 °C for two days, and then later moved to -80 °C for longer-term storage until required.

5.2.5 Intratracheal infection of mice

Mice were weighed, anaesthetised by intraperitoneal injection (with a mixture containing 100 μl of 10 mg/kg ketamine and 1 mg/kg xylazine mixture per 10 g mouse body weight) and suspended by the front teeth using a fine elastic band stretched around a board held at a 45-degree angle. The tongue was extended from the mouth using a cotton applicator to visualise the soft pallet and the trachea visualised using a fibre optic light source and a sheathed 20G paediatric cannula (Terumo Medical, Macquarie Park, NSW) inserted. The cannula needle was withdrawn and a tube containing a small volume of colored dye between two air pockets (to prevent dye inhalation) was briefly connected to the cannula and movement of the dye by respiration observed to confirm intratracheal intubation success (223). A 150 μl volume of air and then 50 μl of PBS, PAO1 or PAO1 and 5 U rhPON2 was drawn up into 250 μl gas-tight Hamilton syringe. The syringe was inserted into the cannula and the liquid and air forcibly ejected into the mouse lung. After removal of the cannula, the tongue was returned into the mouth, artificial tears applied to the eyes and the animals were kept on a warmed heating-pad during recovery. Either six, 12 or 24 hours later mice were euthanised by CO_2 asphyxiation, lungs harvested, diced and tissue immersed in RNAlater® at 4 °C for two days before being transferred to -80 °C for longer-term storage until required.

5.2.6 Lung tissue homogenisation, RNA extraction, qPCR and gene expression analysis

Total RNA was extracted from mouse lungs using TRIzol® reagent according to the manufacturers protocol (Life Technologies, Carlsbad CA). Briefly, the mouse lungs were

added to 1.25 ml of TRIzol® along with 0.5 mL of 0.1 mm zirconia/silica beads (Daintree Scientific, St Helens, TAS, Australia) in 2ml screwcap tubes. Tissue was homogenized for 30 second intervals using a mini-Bead beater (Daintree Scientific) on the fast setting until completely homogenised. After each interval, homogenates were placed on ice every 30 seconds to prevent sample heating. Cellular debris and beads were removed by centrifuging the homogenate at 10,000 *g* for ten minutes at 4 °C. Approximately 1 ml of supernatant was collected per sample and stored at -80 ^{o} C until required. For the final phase of RNA extraction, supernatants were thawed at room temperature, 200 µl of chloroform added/ml and samples shaken vigorously for 15 seconds and then incubated for three minutes at room temperature. Samples were centrifuged at 12,000 g for 15 minutes at 4 °C and the upper RNA containing aqueous phase collected. RNA was precipitated by the addition of 500 µl of 100% isopropanol/ml, samples vortexed, incubated at room temperature for ten minutes and centrifuged at 12,000 g for ten minutes at 4 °C. Pelleted RNA was washed twice with ice-cold 75% ethanol, centrifuged at 7,500 g for five minutes at 4 °C, air dried for ten minutes at room temperature and resuspended in nuclease-free water with heating at 65 °C for ten minutes. RNA quantity and purity were determined using the NanoDrop 1000 spectrophotometer (Thermo Scientific, Waltman, MA, USA) before RNA storage at $^{-}$80 °C until required.

5.2.7 DNase treatment of RNA

The TURBO DNA-*free*™ Kit (Life Technologies) was used to DNase treat RNA according to the manufacturer's instructions. Briefly, 10 x DNase buffer was added to a maximum of 10 µg of RNA (50 µl reaction volume) before addition of 1 µL of TURBO™ DNase (two units) and reactions incubated at 37 °C for 30 minutes. Reactions were stopped by the addition of a 1/10 volume of DNase inactivation reagent and reaction incubation for five minutes at room temperature. Finally, the mixture was centrifuged at 10,000 *g* for 90 seconds at room temperature, RNA containing supernatants transferred to fresh tubes, RNA quantified and stored at $^{-}$80 °C until required.

5.2.8 cDNA synthesis

The Transcriptor First Strand cDNA synthesis kit (Roche, Mannheim, Germany) was used to reverse transcribe RNA to cDNA according to the manufacturer's instructions using both random hexamer and anchored oligo $d(T)_{18}$ primers. One µg of each RNA sample was reverse transcribed to cDNA and then samples diluted 1/5 in nuclease-free water and stored at -20 °C until required.

5.2.9 Quantitative PCR

Duplicate qPCRs were performed on a the LightCycler® 480 II instrument (Roche, Basel, Switzerland) using LightCycler® 480 SYBR Green 1 Master Mix (Roche, Basel, Switzerland) and 96 well plates (Roche, Basel, Switzerland) according to the manufacturer's instructions. Primers used in this study are listed in Table 5.1 (Geneworks, Thebarton SA, AUS) and were based on previous studies or designed in house using were designed using Primer quest (157) and checked for self-complementarity using oligo calculator (158). Each qPCR contained 10 ng of cDNA and a final primer concentration of 1 nM. PCR conditions were as follows: 95 °C for 5 minutes, then 40 cycles of 95 °C for 10 seconds, 60 °C for 10 seconds and 72 °C for 30 seconds. All products underwent melt curve analysis and agarose gel electrophoresis was used to confirm products were of the expected size. Reaction efficiency of all primer pairs was determined in triplicate using serial dilutions of cDNA and efficiency calculated as previously described (159). Gene expression relative to the reference gene (β-actin) was calculated using the $2^{-\Delta\Delta CT}$ (LightCycler® Software, Roche, Basel) method.

Table 5.1. List of primers targeting murine transcripts.

Gene	Forward primer (5'-3')	Reverse primer (5'-3')	Reference
β-actin	AGAGGGAAATCGTGCGTGAC	CAATAGTGATGACCTGGCCGT	(224)
MIP-2	AAGTTTGCCTTFACCCTGAA	AGGCACATCAGGTACGATCC	This study
TNF-a	AGTCCGGGCAGGTCTACTTT	GGTCACTGTCCCAGCATCTT	(225)
IL-6	AGTTGCCTTCTTGGGACTGA	TCCACGATTTCCCAGAGAAC	(226)
IL-17	AGGAATTGTGATTCAGAGGCAGA	ACACGAAGCAGTTTGGGACC	This study
EGR1	AACAACCCTATGAGCACCTG	GAGTCGTTTGGCTGGGATAA	This study
CFTR	GGGAATCAGCGATGGAGAAA	GAAGAAGGCAGAGCTAGTGAAG	This study

5.3.0 Statistical analysis

Because gene expression levels were not normally distributed, all analysis was performed in Graphpad prism (v 6.0; GraphPad, San Diego CA) using non-parametric two-tailed Mann-Whitney U tests and a $P \leq 0.05$ was considered significant.

5.3.1 Enumeration of *P. aeruginosa* load using RT-qPCR

P. aeruginosa strain PAO1 was grown overnight in LB at 37 °C with shaking (150 rpm). To quantify bacterial numbers, cultures were serially diluted (based on OD at A_{600} nm) to approximately 10^{-4} CFU/ml and 100 µl of each dilution spread plated on an LB plate. Plates were incubated overnight at 37 °C, colonies counted, and bacterial number in initial cultures calculated. RNA was isolated from the remaining dilutions after spread plating as described in section 5.2.6, cDNA synthesised and the level of expression of 16S rRNA measured using *psd7* forward and reverse primers (Table 2.1) (153). A standard curve was generated and used to estimate bacterial load per g of mouse lung tissue based on RT-qPCR data as has been previously described (227).

5.3 Results

5.3.1 Bacterial numbers correlate with level of 16S rRNA gene expression

To determine the bacterial burden post-infection of the mouse lung by RT-qPCR, a standard curve was generated comparing bacterial counts (assessed by colony counting, CFU/ml) to expression of 16S rRNA (assessed as crossing-point (Cp). The relationship between these parameters is linear within the range of 10^4 to 10^7 CFU/ml and the correlation coefficient is 0.95 consistent with a previous study (149). High Cp values occur at low 16S rRNA gene expression levels and correlate with low bacterial loads, as expected (Figure 5.1) and bacterial load can be calculated from 16S rRNA gene expression.

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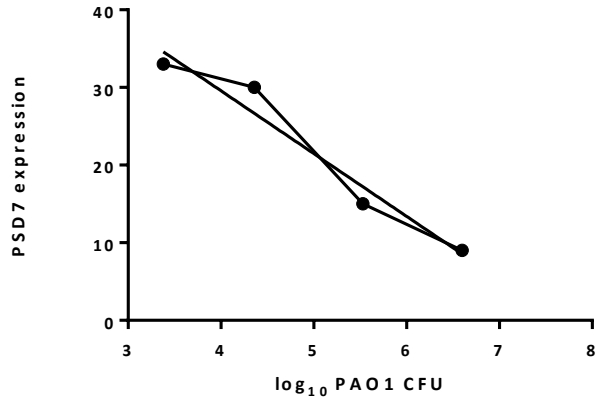

Figure 5.1. Correlation between *P. aeruginosa* numbers and expression of 16S rRNA.

Overnight *P. aeruginosa* strain PAO1 cultures were serially diluted and aliquots (100 μl) of each dilution spread plated, incubated overnight and colonies counted, *n = 2*. RNA was isolated and expression of 16S rRNA measured by RT-qPCR (CP values) from each dilution, *n* = 2

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5.3.2 Intranasal infection of mice with *P. aeruginosa* did not lead to robust lung infection

In order to investigate the ability of rhPON2 to protect mice from acute *P. aeruginosa* lung infection, a robust murine lung infection model was established in our laboratory. Several different models have been developed that vary in the way that the mice are infected. The simplest model uses intranasal instillation (222) and as such was the first model trialled. Mice were infected with *P. aeruginosa* strain PAO1 (5×10^6 CFU) as described (222) and lung tissue harvested 12 hours post-infection, RNA extracted and the level of the bacterial 16S rRNA gene measured and tissue bacterial load calculated from standard curve (relative to expression of murine β-actin). Of the eight mice infected, seven mice had non-detectable levels of *P. aeruginosa* (Figure 5.2) and only one mouse had detectable infection. Possible reasons for the lack of detectable bacteria following this intranasal infection are; i) RT-qPCR is not a reliable method for detecting low levels of bacteria (e.g. less than 1×10^4 CFU, ii) a longer infection time may be required to establish an infection via this route, iii) the mice cleared the infection, and/or iv) a higher bacterial CFU, such as 1×10^8 is required to establish an infection. Given that this model of acute murine lung infection did not lead to a reliable detectable infection, an alternative acute infection model was trialled.

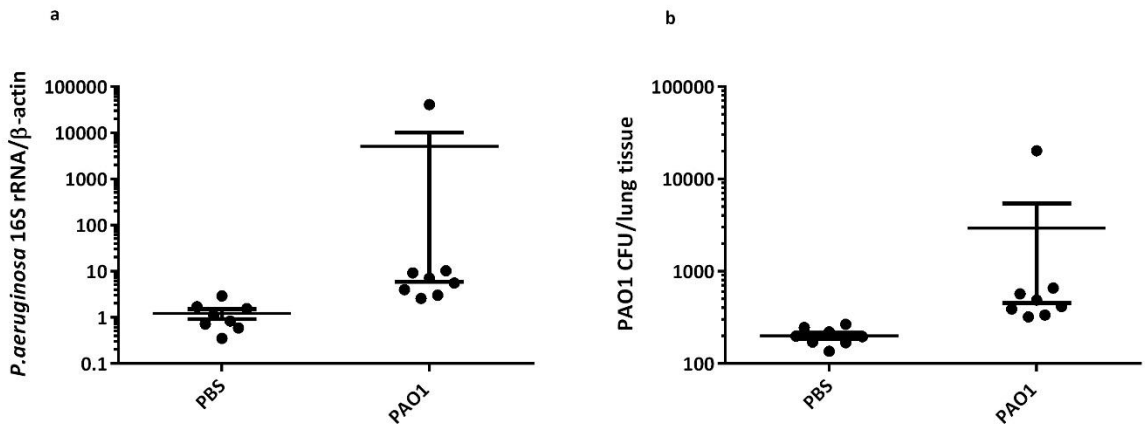

Figure 5.2. *P. aeruginosa* load following intranasal infection.

Groups of eight mice were intranasally infected with either PBS or *P. aeruginosa* strain PAO1 (5 x 10^6 CFU), lungs harvested 12 hours post-infection, RNA extracted and the level of the *P. aeruginosa* 16S rRNA gene assessed by a) RT-qPCR relative to murine β-actin, and b) Estimated PAO1 CFU from PSD7 expression normalised to lung tissue, n = 8

5.3.3 Optimisation of intratracheal *P. aeruginosa* infection of mice

An alternative and commonly used murine infection model relies on intratracheal infection (203). Firstly, in order to demonstrate effective delivery of a compound to the lungs of mice using this method, Evans Blue dye (0.4%, w/v) was introduced to the lungs via an intratracheal cannula following intubation and lung tissue immediately harvested. As can be seen in Figure 5.3, the blue dye was delivered to the lungs with good dispersion to remote lung regions.

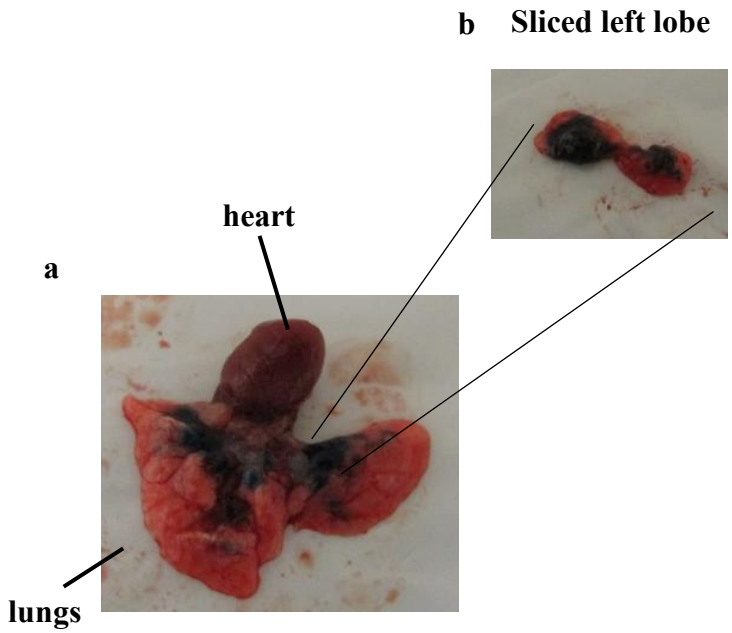

Figure 5.3 Murine lung distribution of a tracking dye after intra-tracheal delivery.
Mice were intubated, a solution of 0.4% Evans Blue introduced to the lungs and animals immediately euthanised. a) Lungs were excised and b) sliced to reveal the distribution of Evans Blue dye throughout the lung, *n* =1

Secondly, once the effectiveness of intratracheal delivery was determined, it was important to determine the optimal time required to establish a detectable acute inflammation-promoting infection in the mice. To do this, C57BL/6J mice were infected intratracheally with *P. aeruginosa* cells (5 x 10^6 CFU) or PBS. Lung tissue was harvested after six, 12 or 24 hours, and bacterial and murine gene expression assessed using RT-qPCR (Figure 5.4**)**. A six-hour infection resulted in only two (of six) mice having detectable levels of *P. aeruginosa* (above background as measured as level of bacterial 16S rRNA expression relative to murine *β-actin*) and no significant lung inflammation (measured as *IL-6*, *MIP-2 (*mouse *IL-8)* expression relative to *β-actin).* However, after 12 hours of infection, there was a significant increase in bacterial load (seen in five out of six mice, Figure 5.4a) and an associated significant increase in expression of markers of murine lung inflammation (Figures 5.4b, c). By 24 hours post-infection, bacterial numbers remained high in only two (of six) mice, although still significantly higher than in controls, and *IL-6* expression, but not *MIP-2,* was significantly elevated compared to uninfected mice. This data suggests that the optimal infection time to detect *P. aeruginosa* load and associated lung inflammation is 12 hours.

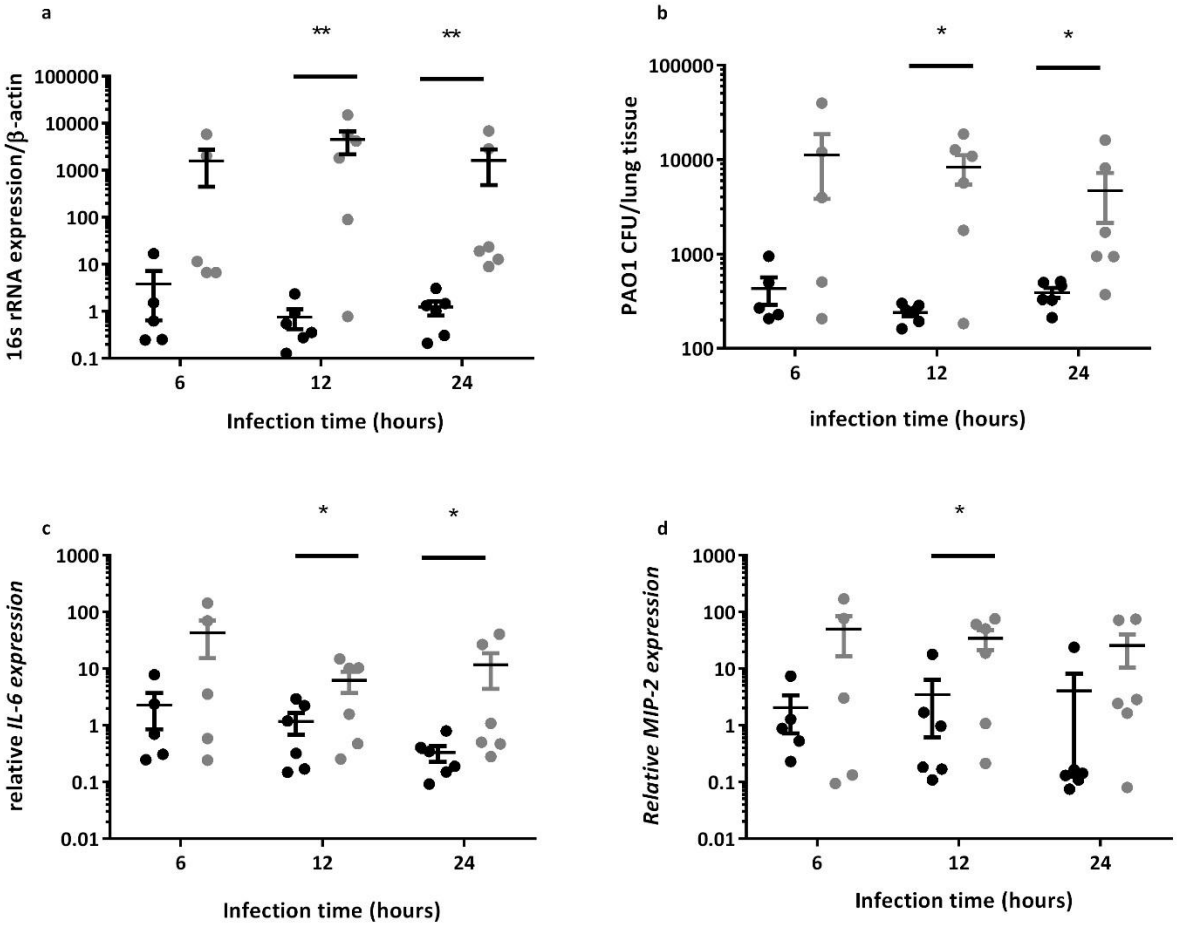

Figure 5.4. Time course to determine optimal P. aeruginosa intratracheal infection time. Groups of six C57BL/6J mice were infected intratracheally with 5 x 10^6 CFU of *P. aeruginosa* strain PAO1 (grey circles) or PBS (black circles) and lung tissue harvested after six, 12 or 24 hours. RNA was extracted and a) bacterial (16S rRNA relative to murine β-actin), b) estimated PAO1 CFU from PSD7 expression normalised to lung tissue and c-d) murine gene expression (*IL-6* and *MIP-2* relative to *β-actin*) assessed by duplicate RT-qPCR. Horizontal lines represent means and error bars SEM. Significant differences assessed using non-parametric two-tailed Mann-Whitney U tests and $P \leq 0.05$ was considered significant. * = $P \leq 0.05$, ** = $P \leq 0.01$.

5.3.5 Administration of rhPON2 into mouse lung at the time of *P. aeruginosa* infection suppressed bacterial induction of murine inflammatory marker IL-6 and its transcription factor EGR1

Previous chapters in this study demonstrated using *in vitro* models that rhPON2 treatment prevents bacterial biofilm formation and expression of QS-related genes, and 3-oxo-C_{12}-HSL-mediated induction of mammalian inflammatory and stress associated pathways. In order to

demonstrate this protection *in vivo,* groups of six to eight C57BL/6J mice were ether infected intra-tracheally with PBS, *P. aeruginosa* cells alone (5 x 10^6 CFU), or bacterial cells with 5 U rhPON2. Lung tissue was harvested 12 hours post-infection and bacterial and murine gene expression was assessed by RT-qPCR (Figure 5.5). Bacterial load in lung tissue was highest (measured as expression level of 16S rRNA relative to murine β-actin) in mice infected with bacterial cells without rhPON2 but not significantly different to lung bacterial levels in mice infected with a mixture of bacteria and rhPON2 (Figure 5.5a).

Bacterial genes required for biofilm and virulence such as *lasI, lasR* and *algD* could not be detected by RT-qPCR in the infected mouse lung tissue, Cp values were greater than 33 (data not shown). This lack of detectable expression may be a consequence of low expression of these genes *in vivo* compared to the level of expression of 16S rRNA. The Cp values for expression of 16S rRNA were between 22-33 (representing a bacterial load of between $1x10^5$ to $1x10^4$ CFU). It is already known that the 16S rRNA gene is expressed at high levels in bacterial cells (thousands of copies per cell, (149)). Therefore, detection of expression of the *lasI* and *lasR* genes that are expected to be expressed at lower levels than the 16S RNA gene would be difficult. For example, a Cp value 9 for the 16s RNA gene corresponds to a Cp value of 22 for the *lasI, lasR,* and *algD* genes (unpublished).

Treatment of mice with rhPON2 at the time of infection significantly supressed bacterial-mediated induction of the *EGR1* and *IL-6* genes and there was a trend towards reduced expression of the *IL-17* gene (Figures 5.5c, d and e, respectively) but no effect on expression of the *MIP-2* (mouse *IL-8*) and *TNF-*α genes (Figures 5.5f and g, respectively). Interestingly, three (of eight) mice (circled on graph) treated with rhPON2 at the time of infection had lower bacterial levels correlating with lower levels of expression of inflammatory genes when compared to mice that were infected without rhPON2 where bacterial load was consistently high in all mice. These three outliers may be associated with these mice either clearing the infection, or it could suggest that rhPON2 treatment led to a lower level of infection in these animals. Although suggestive of rhPON2-mediated reduced bacterial load in these mice, this would need to be investigated in larger animal groups to fully elucidate whether rhPON2 itself reduced bacterial loads.

Murine CFTR gene expression was also assessed in the *in vivo* model and found to be reduced in mice infected with *P. aeruginosa* (Figures 5.5h). However, rhPON2 treatment at the time of

infection did not prevent the *Pseudomonas*-mediated reduction in expression of *CFTR* as had been previously seen for human *CFTR* expression in *in vitro* models (see chapter 4).

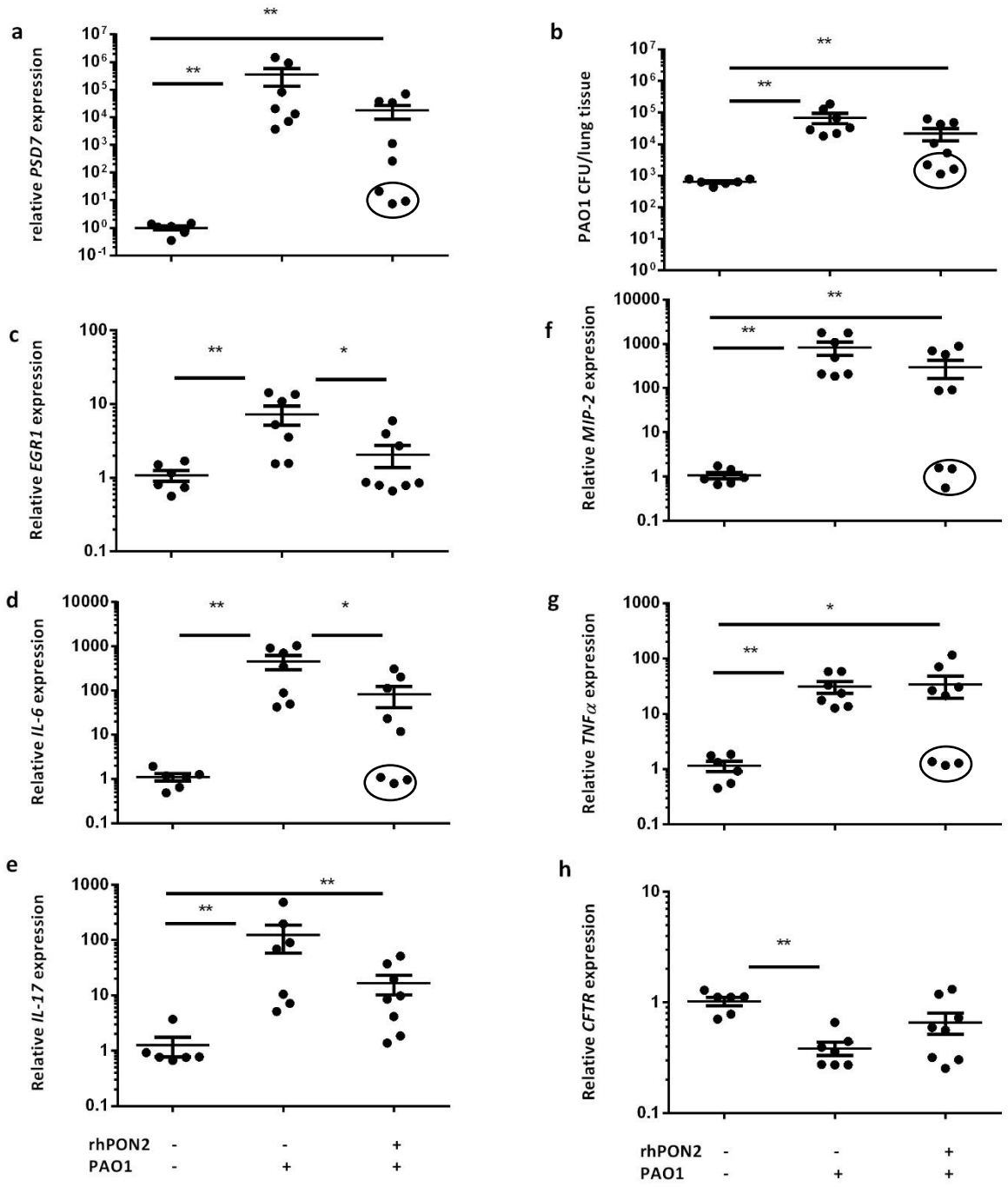

Figure 5.5. rhPON2 supresses *P. aeruginosa*-mediated upregulation of *IL-6* and *EGR1* gene expression.

Groups of 7-8 C57BL/6J mice were infected intratracheally with PBS, *P. aeruginosa* strain PAO1 5 x 10^6 CFU or PAO1 with 5U rhPON2 and lung tissue harvested after 12 hours. RNA

was extracted and a) bacterial (16S rRNA relative to murine β-actin) b) estimated PAO1 CFU from PSD7 expression normalised to lung tissue and b-g) murine gene expression (*EGR1, IL-6, IL-17, MIP-2, TNF-α* and *CFTR* relative to *β-actin*) assessed by duplicate RT-qPCRs. Horizontal lines represent means and error bars SEM. Significant differences assessed using non-parametric two-tailed Mann-Whitney U tests and $P \leq 0.05$ was considered significant. * = $P \leq 0.05$, ** = $P \leq 0.01$.

5.4 Discussion

Investigation of the *in vivo* efficacy of rhPON2 therapy requires the use of an animal model of lung infection. In this study, two methods were trialled to deliver *P. aeruginosa* to the mouse lung, including intranasal and intratracheal approaches. The intratracheal intubation method for delivery of *P. aeruginosa* was a more efficient method to establish an acute *P. aeruginosa* lung infection than intranasal instillation. Four out of a group of six mice were infected based on *16S rRNA* gene expression measurement 12 hours after intratracheal intubation as compared to one (of eight) following intranasal installation of the bacterial cells. Consistent with previous reports, the mice seemed to be able to clear the *P. aeruginosa* infection by 24 hours post-infection, since only two (of six) mice had detectable infection after 24 hours (216, 217). Furthermore, the expression levels of several host inflammatory genes correlated with bacterial load, which suggested the successful establishment of an acute *P. aeruginosa* pulmonary infection in these mice used in the present work (216, 217).

An investigation was performed to determine whether administration of rhPON2 could prevent or reduce *P. aeruginosa* infection and/or bacterial-induced inflammation. Following delivery of the bacterial cells to the mouse lung, bacterial load and the expression of several murine genes whose human counterparts were found to be induced in respiratory cells by 3-oxo-C_{12}-HSL in this study and known to be upregulated in CF patients (34) was assessed. Delivery of bacterial cells with extracellular rhPON2 to the mouse lung seemed to have had very little to no significant effect on the overall bacterial load, even though a small group of mice (three - five out of eight mice) treated with rhPON2 had more than ten times less bacterial burden 12 hours post-infection compared to mice infected with *P. aeruginosa* without rhPON2. Whether rhPON2 is able to reduce overall bacterial load requires further investigation with perhaps larger numbers of mice, however, given the amount of variability seen in the overall bacterial load able to be recovered 12 hours post-infection.

As expected, acute lung infection by *P. aeruginosa* resulted in increased expression of those murine genes encoding pro-inflammatory cytokines *(IL-6, MIP-2, TNF-α* and *IL-17*) and *EGR1,* a transcription factor potentially involved in the regulation of inflammatory responses in mice (228). These data are similar to those showing that acute *P. aeruginosa* lung infection increased the levels TNFα, IL-6, IL-17 and MIP-2 present in bronchoalveolar lavage fluid (BAL) (216, 217, 229). In addition, the rhPON2 seems to have prevented the bacterial-mediated upregulation of the murine *IL-6* gene, which might well be due to the lower than average bacterial burden found in these mice. The pro-inflammatory cytokine IL-6 is a signature cytokine during inflammation and is involved in enhancing the PMN recruitment to the site of infection (230). Wolbeling and colleagues (2011) (216) demonstrated that high IL-6 levels were associated with a high degree of deterioration in murine lung function (216). In support of these results, other independent studies demonstrated that injection of mice with IL-6 caused acute lung injury (231), and that *1L-6* null mice suffered reduced lung injury in response to hypoxia (232). Guillemot and colleagues 2014), (233) demonstrated that *IL-6* null mice infected with otherwise wild-type *P. aeruginosa* survived for longer than control mice, which suggested that an imbalance in the IL-6 response might be detrimental in a *P. aeruginosa* infected lung, at least in mice. Collectively, these results suggested dampened down bacterial-mediated IL-6 responses in the mouse lung such as that achieved by the use of rhPON2 could preserve mouse lung tissue and function in the presence of bacterial infection, which might have important implications for the *P. aeruginosa* infected CF lung. The rhPON2 treatment also prevented *P. aeruginosa*-induced upregulation of *EGR1* expression. A number of other reports have demonstrated that *P. aeruginosa* (and 3-oxo-C_{12}-HSL) induced the upregulation of *EGR1* expression in airway epithelial cells (71, 234). Although, this present study is the first to show that an extracellular rhPON2 can protect host cells from bacterial-induced upregulation of the *IL-6* and *EGR1* genes. One limitation of the present study is that cytokine release profiles (e.g. IL-6 levels) and lung function were not assessed in the *P. aeruginosa* infected mice in the presence and absence of the administration of rhPON2.

Consistent with previous studies, the current study also found that *P. aeruginosa* infection was accompanied by upregulation of *IL-17* and its downstream effector gene *MIP-2*, as well as expression of *TNF-α* in the lungs of infected mice (235, 236) (237). These cytokines normally play a role in neutrophil recruitment to the site(s) of infection and promote bacterial phagocytosis. The 3-oxo-C_{12}-HSL-mediated upregulation of expression of the human *IL-17* gene and TNF-α signalling pathways was also revealed by the RNA-seq analysis of 3-oxo-C_{12}-

HSL-treated cultured human cells (chapter 3). Interestingly, while rhPON2 seemed to mitigate 3-oxo-C_{12}-HSL-induction of the *IL-17* and *TNF-α* genes in human airway epithelial cells, it seemed to have done little, if anything, to prevent *P. aeruginosa*-induced upregulation of *IL-17*, *MIP-2* and *TNF-α* in the mouse lung. One straightforward explanation for these contradictory findings might that upregulation of the *IL-17*, *MIP-2* and *TNF-α* genes in the mouse lung may occur in response to other bacterial associated factors (LPS and flagellin, and the like) besides bacterial AHLs (238), whose overall levels might not be affected by rhPON2.

P. aeruginosa infection downregulated *CFTR* gene expression in the mice, consistent with what occurs when cultured human cells are treated with 3-oxo-C_{12}-HSL (chapter 4 and previous studies (149, 199). However, rhPON2 treatment of mice at the time of infection did not prevent this *P. aeruginosa*-induced down-regulation of *CFTR* gene expression. Yet, there was also no significant difference detected between the level of expression of *CFTR* by uninfected mice and mice treated with rhPON2 at the time of infection, suggesting that subtle differences may be occurring between the groups that have not been fully explored in this study. A future study to determine CFTR protein levels and function could be performed to address this in more detail. Since other pseudomonas secretory factors, besides 3-oxo-C_{12}-HSL have been shown to reduce cellular CFTR protein levels and CFTR-mediated Cl^- ion secretion in airway epithelial cells, such as the bacterially produced CFTR inhibitory factor (CIF) (239).

In summary, this preliminary *in vivo* study using a mouse model of acute lung infection with *P. aeruginosa* suggests that a single dose of rhPON2 treatment at the time of infection can protect lungs from upregulation of the pro-inflammatory gene *IL-6* and its transcriptional regulator *EGR1*. Bacterial-induced upregulation of other inflammatory markers (*IL-17, MIP-2, TNF-α)* and down-regulation of *CFTR* was not prevented by administration of this single dose of rhPON2, but neither were these responses exacerbated, leading to overall rhPON2 being associated with a protective response. These preliminary results need to be verified using an alternative technique, such as ELISAs to detect cytokine secretion in murine bronchial lavage (BAL) fluid and/or a histological examination of murine lungs to observe infection-related pathological changes. In addition, the stability of rhPON2 in the lungs is not known, and multiple doses may be required to fully observe the therapeutic benefits of the rhPON2.

Chapter 6 General Discussion

Persistent airway colonisation and infection by *P. aeruginosa* is a strong predictor of increased morbidity and mortality in people with CF (17). Currently available anti-pseudomonal therapies and the host immune responses fail to eradicate *P. aeruginosa* from the airways of people with CF in part at least because this organism forms complex multicellular structures called biofilms (22). Biofilms protect the bacteria from both antibiotics and host defences and their formation is orchestrated by a complex quorum sensing signalling network, along with activation of bacterial virulence. Biofilm formation relies on bacterial production of an autoinducer molecule, with 3-oxo-C_{12}-HSL being the key autoinducer produced by *P. aeruginosa* (34). In addition, *P. aeruginosa* 3-oxo-C_{12}-HSL adversely modulates diverse functions in mammalian host cells, contributing to the establishment of persistent airway infections in people with CF (68).

For example, *P. aeruginosa* 3-oxo-C_{12}-HSL disrupts the structural integrity of mammalian cells by modifying their actin cytoskeletons, lowering their transepithelial electrical resistance, and by inhibiting their production of essential tight and adheren junction proteins, all of which contribute to the invasiveness of this organism (55, 57). In addition, 3-oxo-C_{12}-HSL has immunomodulatory effects and is a potent inducer of the pro-inflammatory responses in airway epithelial cells, which involves overproduction of inflammatory cytokines, including IL-6, IL-8 and tumour necrosis factor (TNF). It has been postulated that the pro-inflammatory effects of 3-oxo-C_{12}-HSL depend upon the activation of the transcription factor NF-κB, which is regulated by certain MAP kinases of the MAPK signalling pathway (69) (71). While a pro-inflammatory response is important for activating the innate immune responses and for the subsequent clearance of invading microbial pathogens, an over-exaggerated and/or sustained pro-inflammatory response in the presence of 3-oxo-C_{12}-HSL can lead to the recruitment of excessive amounts of immune cells (neutrophils, and the like) to sites of infection, and eventually to extensive tissue damage as is often observed in the lungs of people with CF (14, 181). It has also been widely reported that 3-oxo-C_{12}-HSL can induce apoptosis in human airway epithelial cells, as well as in immune cells (macrophages, neutrophils, lymphocytes, and monocytes), via either the extrinsic (death receptor signalling) or the intrinsic (mitochondrial) apoptotic pathways (93, 94, 175). Apoptosis usually serves as a protective mechanism responsible for removing damaged host cells but upregulation of apoptosis in the presence of 3-oxo-C_{12}-HSL can compromise the host immune defences and allow pathogens like *P. aeruginosa* to evade eradication. Overall, these detrimental effects of 3-oxo-C_{12}-HSL

on host responses act to facilitate the colonisation and persistence of *P. aeruginosa* in the lungs of people with CF (68).

Given the importance of 3-oxo-C_{12}-HSL in regulating biofilm formation and the production of virulence factors by *P. aeruginosa*, as well as its detrimental effects on mammalian host, much recent research has focussed on developing so-called quorum sensing inhibitors (QSIs) and hence 3-oxo-C_{12}-HSL targeted therapies to attenuate the pathogenesis of *P. aeruginosa*. QSI are chemical compounds that interfere with quorum sensing either by inhibiting AHL synthesis (e.g. triclosan (105) and azithromycin (240)), or else by blocking AHLs binding to their cognate receptors (e.g. furanones (112)). One potential drawback associated with the use of QSIs reliant on these mechanisms of action is that they could apply a selective pressure leading to the development of bacterial resistance in much the same way(s) as some conventional antibiotics do (via upregulation of bacterial multidrug efflux pumps, or through ribosomal modification, for example (113, 241)).

Alternative QSI approaches include inactivating bacterial AHLs, for example enzymatic degradation of extracellular 3-oxo-C_{12}-HSL molecules. Lactonases are the most extensively studied AHL degrading enzymes and act by hydrolysing the ester bond of the homoserine lactone ring, thereby preventing the 3-oxo-C_{12}-HSL molecule from binding its bacterial cognate receptor. Many organisms, including bacteria, lower eukaryotes (yeast), plants and animals, produce lactonases (124, 125). Among the lactonases produced by animals, the mammalian paraoxonases PON1, PON2, and PON3, have received a lot of attention. In humans, PON1 and PON3 are mostly secreted into serum, while PON2 remains intracellular. While all three PONs can hydrolyse the 3-oxo-C_{12}-HSL lactone ring, PON2 was demonstrated *in vitro* to have the highest lactonase activity toward 3-oxo-C-$_{12}$-HSL (131). Since PON2 is normally retained intracellularly, its ability to interfere with the QS circuits of exogenous bacteria, and thereby prevent the detrimental effects of bacterial 3-oxo-C_{12}-HSL on host cells, is limited. For this reason, our laboratory is developing and testing a recombinant human PON2 (rhPON2) therapy, to be applied during infection as an extracellular source of PON2, able to target 3-oxo-C_{12}-HSL before it stimulates bacterial biofilm formation or adversely affects host cells (see Figure 6.1). Early proof-of-concept experiments conducted in our laboratory demonstrated that rhPON2 prevented the accumulation of 3-oxo-C_{12}-HSL by *P. aeruginosa* cultures and led to the bacterial cells being more susceptible to the aminoglycoside antibiotic, tobramycin (149).

In the present study, recombinant human PON2 (rhPON2) was produced in insect cells using the method published by Draganov and colleagues (131). The purified rhPON2 was glycosylated and retained the intrinsic ability of *intracellular* PON2 to rapidly hydrolyse bacterial 3-oxo-C_{12}-HSL. When rhPON2 was added to the growth media of stationary-phase *P. aeruginosa* cells, expression of the bacterial quorum sensing regulatory genes, *lasI* and *lasR*, were significantly downregulated, and this response was accompanied by a significant reduction in bacterial biofilm formation.

The capacity of rhPON2 to block the adverse modulatory effects of 3-oxo-C_{12}-HSL on host (human airway epithelial) cell responses was investigated using an unbiased RNA-seq transcriptome analysis. When human respiratory epithelial cells were exposed to 3-oxo-C_{12}-HSL a significant and dramatic modulation of gene expression occurred, with 949 genes being differentially expressed compared to vehicle-treated controls, and of these 828 and 121 were upregulated and downregulated, respectively. This response to 3-oxo-C_{12}-HSL was similar to other published studies (1, 70, 71) with upregulated genes including genes whose products are potentially involved in pro-inflammatory responses (*TNF, NF-κB, IL-8* and *IL-6*) and apoptosis (*CASP8* and *CASP9*), while downregulated genes included many genes associated with maintaining the structural integrity of epithelial cells. Importantly, when the respiratory epithelial cells were treated with a combination of rhPON2 plus 3-oxo-C_{12}-HSL, 634 genes were differentially expressed compared to 3-oxo-C_{12}-HSL-alone treated cells, and of these 68 and 566 were upregulated and downregulated, respectively. Notably, those genes (associated with the pro-inflammatory response and apoptosis) whose expression were significantly upregulated by 3-oxo-C_{12}-HSL exposure, were downregulated in the presence of rhPON2 plus 3-oxo-C_{12}-HSL. For example, rhPON2 mitigated the 3-oxo-C_{12}-HSL-mediated upregulation of several pro-inflammatory genes, including *TNF, IL-8* and *IL-6* and dampened IL-6 and IL-8 release. When CF cells (CuFi-1, delta F508 homozygous) were exposed to 3-oxo-C_{12}-HSL a hyperinflammatory response was induced and involved upregulation of UPR genes. Strikingly, rhPON2 also largely abrogated this 3-oxo-C_{12}-HSL-mediated hyperinflammatory response. Taken together, these data indicated that rhPON2 effectively blocked many of the immunomodulatory effects of 3-oxo-C_{12}-HSL on respiratory epithelial cells.

rhPON2 treatment of host cells also blocked the 3-oxo-C_{12}-HSL-mediated upregulation of several key pro-apoptotic genes, including *Caspase* 9 and *8*, whose encoded proteins act in the intrinsic and extrinsic apoptotic pathways, respectively, and prevented apoptosis. These results are supported by several reports demonstrating the anti-apoptotic properties of *intracellular*

PON2 (Horke *et al.*, 2007; Kim *et al.*, 2011). Intriguingly, recent reports have demonstrated that endogenous PON2 can be pro-apoptotic in tumour cells treated with 3-oxo-C_{12}-HSL (142, 143). It was postulated that when 3-oxo-C_{12}-HSL enters the host cell, the lactone ring is hydrolysed by intracellular PON2 to 3-oxo-C_{12}-HSL-acid. This reaction rapidly acidifies the cytosol and the mitochondria triggering Ca^{2+} liberation and p38 and elongation initiation factor 2 alpha (eIF2α) phosphorylation resulting in apoptosis (144). In our study, rhPON2 hydrolyses the lactone ring of the 3-oxo-C_{12}-HSL in the extracellular environment, thereby reducing hydrolysis by the endogenous *intracellular* PON2 and the resultant acidification suggested to be important for activation of apoptosis. In support of this hypothesis, previous studies demonstrated that 3-oxo-C_{12}-HSL-acid is not cytotoxic to mammalian cells, indicating that an intact lactone ring is important for apoptotic activity (67, 100). Additionally, extracellular rhPON2 blocked 3-oxo-C_{12}-HSL-mediated upregulation of UPR genes such as CHOP, whose protein mediates apoptosis via activation of caspase 3/7.

rhPON2 also potentially protected respiratory cells against the pro-oxidative effects of 3-oxo-C_{12}-HSL as treatment with rhPON2 rescued glutathione (GSH) levels in 3-oxo-C_{12}-HSL-treated cells. Devarajan *et al.* (180) demonstrated that murine peritoneal macrophages with endogenous PON2 knocked-out and exposed to 3-oxo-C_{12}-HSL had decreased GSH levels compared to similarly treated wild-type macrophages. Together these data suggest that PON2 has a role in protecting cells from a 3-oxo-C_{12}-HSL-mediated reduction in glutathione and that treatment with extracellular rhPON2 can further enhance this protection. Interestingly, differential gene expression analysis demonstrated that rhPON2 treatment of cells prevented the 3-oxo-C_{12}-HSL-mediated upregulation of *CHAC1* and *GGT1* whose encoded proteins are involved in degrading GSH (171, 172). Interestingly, a recent study by Corti and colleagues (2017) (172) correlated GGT levels in CF patient sputum samples with inflammatory markers and FEV1% values measured before and after GSH inhalation therapy. These authors demonstrated that high GGT enzyme levels, coupled with increased glutathione degradation, were associated with increased inflammation in CF lungs. It was suggested that the high GGT enzyme levels resulted in increased lung damage as a result of pro-oxidants created during GGT-mediated GSH catabolism (242). Importantly, Corti *et al* (2017) (172) observed a small but significant improvement in lung function in GSH treated patients, only when the patients had low GGT activity. However, they did not correlate GGT and inflammatory levels to *P. aeruginosa* infections, even though 53% of the CF patients had at least one positive airway culture of *P. aeruginosa* a year before the GSH inhalation therapy trial. It is worth noting here

that GGT levels were higher in lungs of mice infected with *P. aeruginosa* compared to not-infected mice (243). Overall, these results suggest that lowering GGT activity and reducing inflammation, as was demonstrated by the rhPON2 treatment, could potentially improve the clinical benefits of inhaled GSH therapy in CF patients.

Among the genes whose expression levels were significantly upregulated in cells treated with rhPON2 plus 3-oxo-C_{12}-HSL, were genes whose protein products are involved in preserving the structural integrity of epithelial cells. Notably the expression of some of these genes were downregulated in cells treated with 3-oxo-C_{12}-HSL without rhPON2. For example, rhPON2 mitigated 3-oxo-C_{12}-HSL-medicated down-regulation of genes whose encoded proteins are involved in maintaining adheren-junctions (*CDH1* and *CTNNB1*) and cytoskeleton remodelling (*IQGAP1, RAC1, CDC42* and *RHO*). Consistent with these data, rhPON2 treatment also prevented 3-oxo-C_{12}-HSL from inducing morphological changes such as ruffling in respiratory epithelial cells. On the basis of these data, a rhPON2 therapy might be able to preserve epithelial cell integrity during *P. aeruginosa* infection, however, further studies are required. For example, investigation of whether rhPON2 can prevent 3-oxo-C_{12}-HSL from decreasing transepithelial electrical resistance (TER) would support this. In this context, Ruffin and colleagues (2016) demonstrated that the QSI, 4-hydroxy-2,5-dimethyl-3(2*H*)-furanone (HDMF), blocked the negative impact of *P. aeruginosa* exoproducts on airway epithelial repair processes such as migration and proliferation (188).

Combined, the *in vitro* data in this study demonstrate that extracellular rhPON2 treatment effectively diminished *P. aeruginosa* biofilm formation and blocked the pro-inflammatory, apoptotic and cell integrity destabilising effects of 3-oxo-C_{12}-HSL on genes in human airway epithelial cells. Additionally, when cells were treated with rhPON2 and 3-oxo-C_{12}-HSL, effectively exposed to 3-oxo-C_{12}-HSL-acid, the measured cells responses (modulation of gene expression, cytokine release, apoptosis and metabolism) closely matched those of not-treated cells or cells treated with rhPON2-alone, indicative of the 3-oxo-C_{12}-HS-acid (or rhPON2) having few adverse (off-target) effects on host cells.

To further explore the potential of rhPON2 therapy and determine if it can protect against bacterial-induced airway inflammation in addition to 3-oxo-C_{12}-HSL-induced inflammation, the therapy was tested in a murine acute lung infection model. The *in vivo* data study demonstrated that rhPON2 treatment does not significantly affect *P. aeruginosa* loads in the murine lungs during a 12-hour infection. Although a small group of infected mice treated with

rhPON2 plus bacteria had more than ten-fold less bacteria compared to mice infected with bacteria alone. The rhPON2 is anti-QS rather than bactericidal (149), however. As a result, it is possible that the low numbers of bacteria collected from the rhPON2 plus bacteria-treated mice reflects rhPON2's ability to prevent biofilm formation, and hence more effective clearance of planktonic (individual) bacterial cells by the murine immune responses. Infection with *P. aeruginosa* was accompanied by the increased expression of several genes *(IL-6, MIP-2, TNF-*α and *IL-17*) encoding pro-inflammatory factors, as well as the *EGR1* gene, which encodes a transcription factor involved in the regulation of murine inflammatory responses (228). rhPON2 treatment blocked bacterial-mediated upregulation of *IL-6* and the gene encoding its transcriptional regulator, *EGR1*. It has been suggested that IL-6 is involved in enhancing the recruitment of polymorphonuclear neutrophils (PMNs) to the sites of infection (230), and increased IL-6 levels have been associated with a high degree of murine lung injury and function decline (216, 231). Therefore, mitigation of this hyperinflammatory response to infection using rhPON2 may protect lungs from PMN-mediated tissue damage. Administering rhPON2 in combination with bacteria did little, however, to dampen the *P. aeruginosa*-mediated upregulation of other pro-inflammatory genes (e.g. *TNF* and *IL-17*), in contrast to its ability to block 3-oxo-C_{12}-HSL-induction of these genes in human airway epithelial cells. One straightforward explanation for these contradictory findings is that upregulation of *IL-17* and *TNF-*α in response to bacterial infection in the mouse lung may involve bacterial associated factors (e.g. LPS and flagellin) in addition to AHLs (238), which are unlikely to have been affected by rhPON2 treatment. These experiments demonstrated that rhPON2 treatment at the time of infection dampened the expression of several host pro-inflammatory genes, suggesting that rhPON2 retained activity *in vivo*. The ability of rhPON2 to diminish the pro-inflammatory responses and associated tissue damage in response to *P. aeruginosa* infection could be further investigated using immunoassays similar to Wolbeling and colleagues (2011) (216) to detect pro-inflammatory cytokines levels in serum and bronchial lavage liquid (BAL) and hematoxylin and eosin (H and E) staining for tissue damage.

Another interesting finding of the *in vivo* mouse model experiments was that *P. aeruginosa* infection downregulated *CFTR* gene expression in the murine lungs, consistent with the effects of 3-oxo-C_{12}-HSL on cultured human airway epithelial cells (this study and previous studies (149). While rhPON2 prevented 3-oxo-C_{12}-HSL-suppression of *CFTR* gene expression in human airway epithelial cells (*in vitro*), it did not prevent the *P. aeruginosa*-induced downregulation of *CFTR* gene expression in the murine lungs. One possible explanation for

these conflicting results is that *P. aeruginosa* can reduce CFTR protein levels in host cells by secreting a CFTR inhibitory factor (CIF), and hence independent of 3-oxo-C_{12}-HSL (239, 244).

Conclusion

The present study demonstrated proof-of-principle that rhPON2 rapidly degrades bacterial 3-oxo-C_{12}-HSL, diminishes *P. aeruginosa* biofilm formation, and blocks 3-oxo-C_{12}-HSL-mediated dysregulation of host cell structural integrity, inflammatory and apoptotic responses. In addition, rhPON2 provides partial protection against *P. aeruginosa*-mediated activation of pro-inflammatory response in the lungs of infected mice. Together, these data provide strong evidence supporting the potential benefits of rhPON2 as a novel and effective treatment option for people with CF.

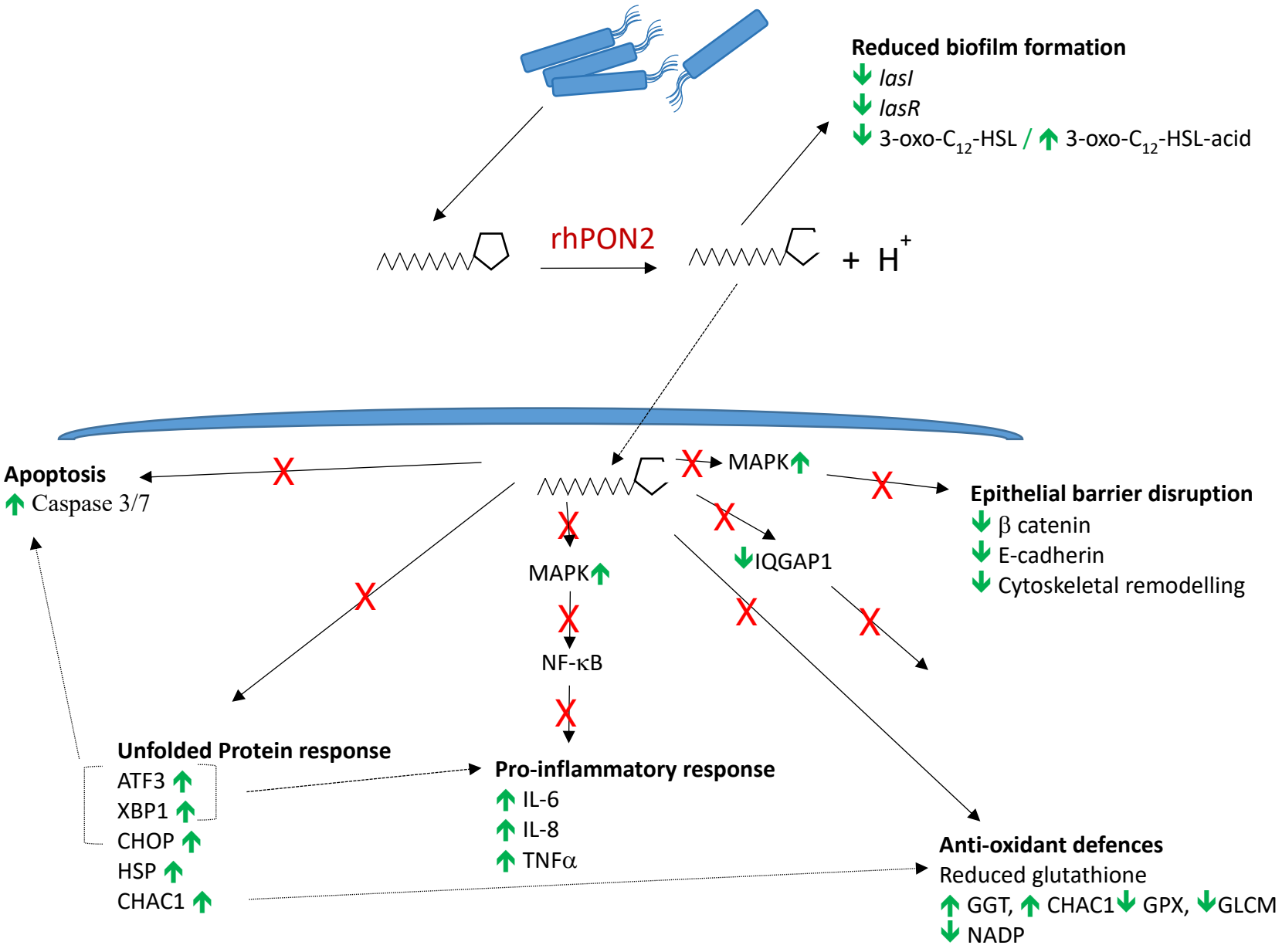
Reduced biofilm formation
lasI
lasR
3-oxo-C12-HSL / 3-oxo-C12-HSL-acid
rhPON2
+ H+
Apoptosis
Caspase 3/7
MAPK
Epithelial barrier disruption
β catenin
E-cadherin
Cytoskeletal remodelling
IQGAP1
MAPK
NF-κB
Unfolded Protein response
ATF3
XBP1
CHOP
HSP
CHAC1
Pro-inflammatory response
IL-6
IL-8
TNFα
Anti-oxidant defences
Reduced glutathione
GGT, CHAC1 GPX, GLCM
NADP

Figure 6.1. Schematic overview of the protective effects of rhPON2 on bacteria and host cells.

rhPON2 hydrolyses 3-oxo-C_{12}-HSL to 3-oxo-C_{12}-HSL-acid. Application of extracellular rhPON2 to *P. aeruginosa* cultures inhibits 3-oxo-C_{12}-HSL accumulation in supernatants and reduces expression of quorum sensing genes and formation of bacterial biofilms. rhPON2 treatment of cultured host cells prior to exposure to 3-oxo-C_{12}-HSL blocks many of the detrimental effects of 3-oxo-C_{12}-HSL (blocking upregulation of pro-inflammatory/stress responses and apoptosis, and down-regulation of anti-oxidant defences and reduced epithelial barrier integrity). Pathways were identified based on differential gene expression analysis of respiratory epithelial cells treated with rhPON2 plus 3-oxo-C_{12}-HSL compared to cells treated with 3-oxo-C_{12}-HSL alone and key genes in those pathways that were identified as being modulated are listed under the pathway with green arrows indicating either up- or down-regulation of that gene. Bold arrows joining pathways are supported by differential gene expression analysis and/or functional assays. Dotted lines are interactions supported in the literature.

Future Directions

Current anti-pseudomonal treatments are ineffective at eradicating chronic *P. aeruginosa* infections in the CF lung mainly because *P. aeruginosa* forms biofilms. This study demonstrated that rhPON2 reduced *P. aeruginosa* biofilm formation and added to previous work conducted in our laboratory, which demonstrated that rhPON2 prevented 3-oxo-C_{12}-HSL accumulation in *P. aeruginosa* cultures and increased susceptibility to the aminoglycoside antibiotic, tobramycin (149). Future studies using rhPON2 in combination with anti-pseudomonals (e.g. tobramycin and/or azithromycin) in a murine *P. aeruginosa* lung infection model could reveal the potential of rhPON2 to facilitate antibiotic and host immune mediated bacterial killing and/or clearance *in vivo*.

rhPON2-mediated AHL inactivation could also prove therapeutically useful in other *P. aeruginosa* infections besides lung infections in people with CF. *P. aeruginosa* is a serious human opportunistic pathogen that can cause life threating disease in people with other medical conditions such as people with severe burns (27), diminished immune response systems (28) and other respiratory diseases such as pneumonia and COPD (29). A recent study by Gupta and colleagues (245) using a *P. aeruginosa* murine burn wound model, demonstrated the efficacy of a topical therapy consisting of purified lactonase, isolated from *Bacillus sp,* and the antibiotic ciprofloxacin in reducing inflammation and improving the survival of infected mice. Thus, the potential of rhPON2 as a therapy for *P. aeruginosa* infections could be further underscored in this burn wound model.

It would be important to determine in future whether rhPON2 can also inhibit biofilm formation by other Gram-negative bacteria and similarly protect host cells from their AHL-mediated damage. A complex mixture of microorganisms are usually detectable in the airways of people with CF, and some colonising bacteria like *Burkholderia cepacia* complex *(BCC)* (246) and *Pandorea sp.* (247), also appear to utilise the *N*-octanoyl-L-homoserine lactone (C8-AHL) for quorum sensing. It would be of interest to determine whether rhPON2 could be effective at blocking quorum sensing by these sorts of bacteria, and any potential detrimental effects of their AHLs on mammalian host cells.

This study demonstrated that exposure of host cells to 3-oxo-C_{12}-HSL reduced *CFTR* gene expression, which in light of a recent report demonstrating that exo-products from *P. aeruginosa* (such as CIF) reduced *CFTR* gene expression (199), may have important implications for the efficacy of CFTR correctors. Thus for example, Trinh and colleagues

(2015) (199) demonstrated that *P. aeruginosa* exo-products affected the efficacy of the CFTR corrector, 4-cyclohexyloxy-2-(1-[4-(4-methoxy-benzenesulfonyl)-piperazin-1-yl]-ethyl)-quinazoline (VRT-325) on CF (F508del/F508del) airway epithelial cells, insofar as less CFTR protein was detected at the apical membrane in treated cells compared to not-treated controls. In the present study, rhPON2 treatment of epithelial cells prior to 3-oxo-C_{12}-HSL exposure protected them from the 3-oxo-C_{12}-HSL-mediated reduction in *CFTR* expression, and hence could potentially improve the efficacy of a CFTR corrector when used in a combined therapy.

In conclusion, rhPON2 therapy, or a similar therapeutic strategy, may in future be an important component of a multi-pronged CF treatment, that could include antibiotics, mucolytics, anti-inflammatories, and CFTR correctors.

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Appendix

Table A1. List of differentially expressed genes (DEGs) control to 50 µM 3-oxo-C_{12}-HSL

Ensembl	Symbol	log_2FC	P. Val
ENSG00000225217	HSPA7	6.866	5.30E-17
ENSG00000173110	HSPA6	6.842	8.00E-24
ENSG00000120738	EGR1	4.107	1.50E-30
ENSG00000232810	TNF	4.103	6.11E-12
ENSG00000198576	ARC	4.043	4.97E-16
ENSG00000125998	FAM83C	3.718	3.60E-11
ENSG00000204389	HSPA1A	3.595	8.17E-30
ENSG00000149599	DUSP15	3.453	1.17E-10
ENSG00000130518	KIAA1683	3.133	6.68E-10
ENSG00000204388	HSPA1B	3.100	4.68E-28
ENSG00000064300	NGFR	3.044	9.25E-20
ENSG00000121068	TBX2	3.035	2.33E-08
ENSG00000140403	DNAJA4	3.020	9.50E-25
ENSG00000135625	EGR4	2.989	3.82E-12
ENSG00000158014	SLC30A2	2.962	2.14E-10
ENSG00000169429	CXCL8	2.875	5.90E-27
ENSG00000203804	ADAMTSL4-AS1	2.837	5.78E-09
ENSG00000122877	EGR2	2.828	4.19E-20
ENSG00000113070	HBEGF	2.729	5.90E-27
ENSG00000280213	UCKL1-AS1	2.598	3.08E-12
ENSG00000158050	DUSP2	2.532	3.29E-19
ENSG00000184557	SOCS3	2.530	2.93E-21
ENSG00000163449	TMEM169	2.525	7.96E-08
ENSG00000116990	MYCL	2.475	4.00E-16
ENSG00000187621	TCL6	2.429	6.01E-09
ENSG00000204390	HSPA1L	2.407	1.33E-13
ENSG00000166670	MMP10	2.394	3.34E-09
ENSG00000109758	HGFAC	2.390	2.13E-08
ENSG00000186469	GNG2	2.350	9.29E-12
ENSG00000197647	ZNF433	2.344	1.65E-11
ENSG00000087074	PPP1R15A	2.342	1.30E-25
ENSG00000144802	NFKBIZ	2.333	5.37E-23
ENSG00000272734	ADIRF-AS1	2.291	1.86E-20
ENSG00000111912	NCOA7	2.274	1.16E-24
ENSG00000223547	ZNF844	2.267	1.39E-08
ENSG00000105327	BBC3	2.241	6.34E-17

ENSG00000164949	GEM	2.224	8.43E-18
ENSG00000173334	TRIB1	2.214	6.41E-24
ENSG00000164082	GRM2	2.178	1.43E-06
ENSG00000132002	DNAJB1	2.176	3.30E-27
ENSG00000219891	ZSCAN12P1	2.175	2.00E-11
ENSG00000057657	PRDM1	2.167	3.45E-19
ENSG00000128590	DNAJB9	2.145	1.14E-17
ENSG00000153234	NR4A2	2.140	4.92E-18
ENSG00000118503	TNFAIP3	2.127	4.68E-28
ENSG00000175197	DDIT3	2.125	9.35E-22
ENSG00000228705	LINC00659	2.111	2.19E-08
ENSG00000260941	LINC00622	2.107	1.65E-10
ENSG00000111644	ACRBP	2.100	1.91E-06
ENSG00000128965	CHAC1	2.078	7.38E-23
ENSG00000128917	DLL4	2.074	2.58E-07
ENSG00000068976	PYGM	2.065	2.58E-07
ENSG00000149968	MMP3	2.056	2.14E-12
ENSG00000172818	OVOL1	2.055	3.95E-19
ENSG00000197857	ZNF44	1.995	3.12E-17
ENSG00000198342	ZNF442	1.980	1.36E-07
ENSG00000162616	DNAJB4	1.971	1.24E-19
ENSG00000183508	FAM46C	1.962	3.86E-10
ENSG00000179388	EGR3	1.947	1.03E-18
ENSG00000172602	RND1	1.934	7.39E-10
ENSG00000196338	NLGN3	1.931	2.53E-06
ENSG00000123358	NR4A1	1.920	1.29E-20
ENSG00000139597	N4BP2L1	1.915	1.73E-07
ENSG00000164463	CREBRF	1.909	2.48E-17
ENSG00000182393	IFNL1	1.888	9.45E-06
ENSG00000039600	SOX30	1.888	3.05E-06
ENSG00000113369	ARRDC3	1.873	4.06E-22
ENSG00000204385	SLC44A4	1.866	8.78E-07
ENSG00000172244	C5orf34	1.848	2.60E-20
ENSG00000126368	NR1D1	1.835	1.92E-22
ENSG00000123610	TNFAIP6	1.834	6.86E-14
ENSG00000130766	SESN2	1.814	1.69E-22
ENSG00000073756	PTGS2	1.801	7.96E-20
ENSG00000130513	GDF15	1.787	1.75E-11
ENSG00000165879	FRAT1	1.783	4.87E-09
ENSG00000107968	MAP3K8	1.782	2.26E-12
ENSG00000197044	ZNF441	1.771	4.88E-15
ENSG00000100906	NFKBIA	1.771	1.19E-25
ENSG00000174327	SLC16A13	1.768	9.12E-14

ENSG00000137193	PIM1	1.754	7.32E-20
ENSG00000160888	IER2	1.748	3.49E-21
ENSG00000171786	NHLH1	1.748	2.75E-06
ENSG00000136244	IL6	1.739	2.60E-17
ENSG00000248323	LUCAT1	1.726	1.24E-08
ENSG00000123870	ZNF137P	1.726	1.91E-08
ENSG00000108932	SLC16A6	1.708	3.82E-12
ENSG00000175155	YPEL2	1.708	4.04E-12
ENSG00000120694	HSPH1	1.707	1.16E-24
ENSG00000188868	ZNF563	1.686	1.43E-07
ENSG00000114315	HES1	1.684	1.70E-20
ENSG00000169242	EFNA1	1.673	1.43E-23
ENSG00000160570	DEDD2	1.661	2.60E-20
ENSG00000179674	ARL14	1.659	9.44E-06
ENSG00000144655	CSRNP1	1.654	2.60E-20
ENSG00000267500	ZNF887P	1.652	6.42E-07
ENSG00000049249	TNFRSF9	1.638	2.12E-07
ENSG00000146278	PNRC1	1.632	5.30E-22
ENSG00000109771	LRP2BP	1.618	4.58E-07
ENSG00000249855	EEF1A1P19	1.611	1.26E-06
ENSG00000008516	MMP25	1.609	8.05E-07
ENSG00000171223	JUNB	1.606	8.70E-22
ENSG00000111254	AKAP3	1.606	4.58E-08
ENSG00000267270	PARD6G-AS1	1.586	8.81E-07
ENSG00000163545	NUAK2	1.576	2.22E-17
ENSG00000164236	ANKRD33B	1.574	4.83E-18
ENSG00000178662	CSRNP3	1.568	1.44E-09
ENSG00000130052	STARD8	1.564	1.72E-06
ENSG00000198551	ZNF627	1.563	2.67E-16
ENSG00000134107	BHLHE40	1.555	3.32E-22
ENSG00000188177	ZC3H6	1.551	6.97E-12
ENSG00000167874	TMEM88	1.547	4.71E-10
ENSG00000253958	CLDN23	1.540	1.45E-09
ENSG00000118523	CTGF	1.537	7.11E-18
ENSG00000085514	PILRA	1.529	1.68E-06
ENSG00000141682	PMAIP1	1.527	4.51E-19
ENSG00000159388	BTG2	1.523	3.39E-18
ENSG00000089116	LHX5	1.520	8.63E-08
ENSG00000155090	KLF10	1.515	2.22E-22
ENSG00000125740	FOSB	1.511	2.71E-17
ENSG00000095739	BAMBI	1.504	1.10E-05
ENSG00000218358	RAET1K	1.502	3.33E-06
ENSG00000188766	SPRED3	1.500	1.30E-14

ENSG00000136367	ZFHX2	1.499	2.05E-07
ENSG00000164400	CSF2	1.496	1.91E-08
ENSG00000117425	PTCH2	1.483	1.44E-05
ENSG00000205181	LINC00654	1.476	2.01E-04
ENSG00000135407	AVIL	1.474	1.94E-07
ENSG00000162772	ATF3	1.471	9.87E-20
ENSG00000151929	BAG3	1.468	1.06E-24
ENSG00000177606	JUN	1.467	1.81E-21
ENSG00000084110	HAL	1.455	4.29E-06
ENSG00000204923	FBXO48	1.449	9.67E-12
ENSG00000149781	FERMT3	1.444	8.26E-06
ENSG00000204618	RNF39	1.441	1.93E-12
ENSG00000159588	CCDC17	1.424	2.07E-06
ENSG00000138835	RGS3	1.420	4.44E-16
ENSG00000125657	TNFSF9	1.414	1.81E-08
ENSG00000141738	GRB7	1.410	4.32E-18
ENSG00000099251	HSD17B7P2	1.407	2.59E-08
ENSG00000181016	LSMEM1	1.402	4.24E-05
ENSG00000196421	LINC00176	1.399	3.90E-07
ENSG00000102385	DRP2	1.396	2.22E-07
ENSG00000141579	ZNF750	1.388	9.81E-09
ENSG00000177426	TGIF1	1.377	4.57E-20
ENSG00000137331	IER3	1.375	4.38E-22
ENSG00000144445	KANSL1L	1.373	1.03E-12
ENSG00000187479	C11orf96	1.353	8.85E-07
ENSG00000051108	HERPUD1	1.343	6.88E-21
ENSG00000140450	ARRDC4	1.340	1.03E-18
ENSG00000143322	ABL2	1.335	3.45E-19
ENSG00000188171	ZNF626	1.329	1.21E-06
ENSG00000164406	LEAP2	1.323	9.70E-05
ENSG00000188033	ZNF490	1.323	1.25E-05
ENSG00000267858	MZF1-AS1	1.320	1.52E-05
ENSG00000243649	CFB	1.313	8.61E-07
ENSG00000232040	ZBED9	1.311	4.78E-10
ENSG00000166669	ATF7IP2	1.310	8.17E-08
ENSG00000143507	DUSP10	1.298	7.83E-15
ENSG00000214783	POLR2J4	1.294	1.11E-05
ENSG00000146426	TIAM2	1.292	5.40E-09
ENSG00000100031	GGT1	1.291	1.88E-05
ENSG00000226763	SRRM5	1.281	1.95E-04
ENSG00000121931	LRIF1	1.263	3.01E-19
ENSG00000188277	C15orf62	1.261	1.52E-05
ENSG00000225828	FAM229A	1.257	5.00E-09

ENSG00000131471	AOC3	1.250	8.90E-09
ENSG00000146232	NFKBIE	1.245	8.91E-16
ENSG00000179476	C14orf28	1.244	1.72E-07
ENSG00000133874	RNF122	1.244	1.36E-06
ENSG00000167995	BEST1	1.234	7.95E-04
ENSG00000150347	ARID5B	1.228	3.01E-19
ENSG00000115963	RND3	1.222	9.35E-20
ENSG00000213096	ZNF254	1.218	3.42E-12
ENSG00000169155	ZBTB43	1.217	4.36E-19
ENSG00000172748	ZNF596	1.217	1.43E-06
ENSG00000204815	TTC25	1.212	1.19E-05
ENSG00000115738	ID2	1.210	2.62E-06
ENSG00000130783	CCDC62	1.210	9.80E-04
ENSG00000110876	SELPLG	1.207	1.64E-05
ENSG00000163874	ZC3H12A	1.207	1.28E-20
ENSG00000197020	ZNF100	1.200	9.64E-13
ENSG00000218537	MIF-AS1	1.198	4.66E-05
ENSG00000100027	YPEL1	1.191	1.35E-05
ENSG00000138764	CCNG2	1.191	1.94E-18
ENSG00000172059	KLF11	1.190	2.04E-16
ENSG00000059728	MXD1	1.189	3.69E-17
ENSG00000198855	FICD	1.183	1.16E-08
ENSG00000213199	ASIC3	1.178	6.65E-06
ENSG00000235823	OLMALINC	1.177	1.86E-13
ENSG00000258839	MC1R	1.174	2.08E-09
ENSG00000184574	LPAR5	1.167	1.91E-14
ENSG00000205085	FAM71F2	1.159	1.82E-05
ENSG00000100100	PIK3IP1	1.159	5.61E-14
ENSG00000141622	RNF165	1.156	1.83E-12
ENSG00000140379	BCL2A1	1.154	2.37E-06
ENSG00000128165	ADM2	1.149	2.16E-11
ENSG00000135338	LCA5	1.145	7.79E-10
ENSG00000151014	NOCT	1.138	1.90E-12
ENSG00000188818	ZDHHC11	1.133	3.60E-07
ENSG00000197279	ZNF165	1.130	1.51E-10
ENSG00000187105	HEATR4	1.124	2.53E-04
ENSG00000128016	ZFP36	1.124	5.11E-20
ENSG00000159873	CCDC117	1.122	3.11E-10
ENSG00000107864	CPEB3	1.122	4.90E-09
ENSG00000151687	ANKAR	1.118	1.93E-06
ENSG00000126562	WNK4	1.117	3.44E-10
ENSG00000173320	STOX2	1.115	5.32E-08
ENSG00000203865	ATP1A1-AS1	1.115	1.88E-03

ENSG00000115008	IL1A	1.111	1.14E-19
ENSG00000167550	RHEBL1	1.108	9.15E-08
ENSG00000163734	CXCL3	1.106	9.00E-17
ENSG00000118292	C1orf54	1.102	5.87E-04
ENSG00000251192	ZNF674	1.099	2.59E-08
ENSG00000171988	JMJD1C	1.098	2.53E-19
ENSG00000114796	KLHL24	1.091	3.66E-12
ENSG00000143110	C1orf162	1.088	2.48E-04
ENSG00000270069	MIR222HG	1.085	1.57E-09
ENSG00000269834	ZNF528-AS1	1.084	1.41E-05
ENSG00000110944	IL23A	1.082	1.37E-04
ENSG00000183783	KCTD8	1.082	1.99E-05
ENSG00000204947	ZNF425	1.080	1.65E-08
ENSG00000107742	SPOCK2	1.079	5.94E-04
ENSG00000111266	DUSP16	1.076	1.67E-16
ENSG00000135605	TEC	1.076	1.36E-03
ENSG00000166398	KIAA0355	1.074	1.21E-14
ENSG00000124549	BTN2A3P	1.069	4.94E-08
ENSG00000072201	LNX1	1.068	1.93E-03
ENSG00000166387	PPFIBP2	1.067	2.15E-07
ENSG00000143178	TBX19	1.061	1.62E-05
ENSG00000185262	UBALD2	1.061	2.02E-15
ENSG00000179397	C1orf101	1.060	1.34E-04
ENSG00000139318	DUSP6	1.057	1.19E-20
ENSG00000196110	ZNF699	1.056	2.37E-09
ENSG00000116285	ERRFI1	1.054	6.96E-20
ENSG00000125735	TNFSF14	1.051	6.86E-06
ENSG00000115844	DLX2	1.051	1.57E-10
ENSG00000251022	THAP9-AS1	1.048	7.77E-13
ENSG00000149260	CAPN5	1.043	3.24E-08
ENSG00000152359	POC5	1.041	2.14E-15
ENSG00000124602	UNC5CL	1.039	1.58E-04
ENSG00000127528	KLF2	1.039	3.02E-04
ENSG00000196967	ZNF585A	1.039	2.37E-08
ENSG00000183696	UPP1	1.038	2.49E-21
ENSG00000278530	CHMP1B2P	1.037	3.27E-04
ENSG00000173041	ZNF680	1.037	9.03E-13
ENSG00000103313	MEFV	1.031	2.28E-03
ENSG00000111981	ULBP1	1.030	1.17E-10
ENSG00000231584	FAHD2CP	1.030	8.25E-05
ENSG00000172803	SNX32	1.028	6.24E-03
ENSG00000158055	GRHL3	1.022	4.30E-12
ENSG00000125812	GZF1	1.021	1.01E-16

ENSG00000079335	CDC14A	1.017	3.05E-09
ENSG00000234684	SDCBP2-AS1	1.017	9.32E-10
ENSG00000204248	COL11A2	1.017	2.44E-04
ENSG00000108342	CSF3	1.014	1.77E-16
ENSG00000165259	HDX	1.011	4.93E-07
ENSG00000277462	ZNF670	1.009	3.91E-09
ENSG00000189014	FAM35DP	1.008	1.05E-03
ENSG00000154822	PLCL2	1.007	6.21E-05
ENSG00000197013	ZNF429	1.006	1.73E-04
ENSG00000159885	ZNF222	1.004	1.55E-05
ENSG00000197124	ZNF682	1.003	1.68E-04
ENSG00000214954	LRRC69	1.002	7.50E-03
ENSG00000188906	LRRK2	1.002	1.20E-04
ENSG00000265972	TXNIP	1.002	1.90E-17
ENSG00000197935	ZNF311	1.001	4.98E-08
ENSG00000124635	HIST1H2BJ	0.999	6.51E-05
ENSG00000164749	HNF4G	0.999	1.41E-03
ENSG00000181896	ZNF101	0.995	5.52E-12
ENSG00000168772	CXXC4	0.995	4.05E-04
ENSG00000262001	DLGAP1-AS2	0.993	6.31E-06
ENSG00000131797	CLUHP3	0.993	1.42E-12
ENSG00000047346	FAM214A	0.992	7.87E-14
ENSG00000243244	STON1	0.990	4.79E-04
ENSG00000177842	ZNF620	0.989	1.47E-05
ENSG00000152926	ZNF117	0.985	3.34E-09
ENSG00000146776	ATXN7L1	0.978	1.22E-11
ENSG00000120616	EPC1	0.976	1.03E-15
ENSG00000169989	TIGD4	0.974	5.97E-03
ENSG00000113916	BCL6	0.974	1.80E-13
ENSG00000178809	TRIM73	0.973	5.87E-05
ENSG00000152380	FAM151B	0.971	9.77E-04
ENSG00000234390	USP27X-AS1	0.970	5.41E-04
ENSG00000180626	ZNF594	0.969	2.89E-08
ENSG00000198780	FAM169A	0.969	1.09E-12
ENSG00000271013	LRRC37A9P	0.968	8.80E-04
ENSG00000204569	PPP1R10	0.968	2.19E-20
ENSG00000135835	KIAA1614	0.966	1.51E-05
ENSG00000167525	PROCA1	0.966	3.60E-06
ENSG00000133069	TMCC2	0.965	4.46E-06
ENSG00000110172	CHORDC1	0.965	1.48E-15
ENSG00000069712	KIAA1107	0.964	8.22E-07
ENSG00000105750	ZNF85	0.963	2.40E-08
ENSG00000158373	HIST1H2BD	0.962	4.22E-07

ENSG00000163009	C2orf48	0.961	2.29E-04
ENSG00000128342	LIF	0.960	1.81E-18
ENSG00000242349	NPPA-AS1	0.959	4.99E-03
ENSG00000172738	TMEM217	0.959	2.72E-07
ENSG00000269837	IPO5P1	0.959	2.72E-04
ENSG00000172361	CFAP53	0.958	4.95E-05
ENSG00000112343	TRIM38	0.958	1.36E-14
ENSG00000198435	NRARP	0.957	1.49E-11
ENSG00000165874	FAM35BP	0.956	4.40E-05
ENSG00000226314	ZNF192P1	0.956	1.06E-03
ENSG00000196268	ZNF493	0.956	1.57E-06
ENSG00000113448	PDE4D	0.954	3.36E-13
ENSG00000078403	MLLT10	0.951	1.10E-16
ENSG00000132801	ZSWIM3	0.950	1.25E-09
ENSG00000171121	KCNMB3	0.948	2.36E-04
ENSG00000172345	STARD5	0.946	7.39E-10
ENSG00000164104	HMGB2	0.945	1.44E-18
ENSG00000086544	ITPKC	0.942	1.86E-14
ENSG00000172086	KRCC1	0.942	7.28E-15
ENSG00000277449	CEBPB-AS1	0.941	3.66E-04
ENSG00000196757	ZNF700	0.941	2.26E-09
ENSG00000184545	DUSP8	0.930	1.17E-08
ENSG00000129173	E2F8	0.929	3.63E-15
ENSG00000148926	ADM	0.927	4.96E-12
ENSG00000138166	DUSP5	0.925	1.99E-14
ENSG00000116761	CTH	0.925	3.00E-09
ENSG00000120129	DUSP1	0.923	7.17E-19
ENSG00000214145	LINC00887	0.922	4.09E-04
ENSG00000178607	ERN1	0.922	1.04E-15
ENSG00000165244	ZNF367	0.920	2.19E-15
ENSG00000173212	MAB21L3	0.920	3.86E-06
ENSG00000156509	FBXO43	0.919	3.06E-04
ENSG00000264247	LINC00909	0.917	2.88E-09
ENSG00000143457	GOLPH3L	0.917	3.46E-13
ENSG00000226312	CFLAR-AS1	0.915	2.57E-04
ENSG00000234667	ACTBP13	0.913	1.52E-04
ENSG00000164309	CMYA5	0.910	3.74E-05
ENSG00000160588	MPZL3	0.909	2.80E-13
ENSG00000099860	GADD45B	0.908	1.32E-13
ENSG00000124762	CDKN1A	0.908	2.44E-18
ENSG00000120885	CLU	0.905	2.89E-13
ENSG00000167232	ZNF91	0.904	1.18E-10
ENSG00000198879	SFMBT2	0.902	9.28E-05

ENSG00000165030	NFIL3	0.902	1.03E-15
ENSG00000119508	NR4A3	0.900	2.21E-06
ENSG00000166046	TCP11L2	0.899	3.97E-05
ENSG00000165861	ZFYVE1	0.896	7.08E-12
ENSG00000172071	EIF2AK3	0.895	3.53E-13
ENSG00000139132	FGD4	0.894	2.51E-15
ENSG00000173391	OLR1	0.893	1.85E-06
ENSG00000136237	RAPGEF5	0.892	4.84E-09
ENSG00000111816	FRK	0.892	4.81E-09
ENSG00000064989	CALCRL	0.891	8.37E-04
ENSG00000111276	CDKN1B	0.890	1.29E-14
ENSG00000172687	ZNF738	0.889	2.52E-09
ENSG00000198585	NUDT16	0.888	7.77E-15
ENSG00000257702	LBX2-AS1	0.887	4.22E-04
ENSG00000164603	C7orf60	0.887	8.38E-09
ENSG00000162999	DUSP19	0.886	1.58E-03
ENSG00000227268	KLLN	0.884	4.23E-03
ENSG00000164070	HSPA4L	0.882	3.15E-17
ENSG00000109927	TECTA	0.882	4.24E-03
ENSG00000196705	ZNF431	0.881	6.55E-13
ENSG00000279192	PWAR5	0.880	4.39E-05
ENSG00000196345	ZKSCAN7	0.879	7.11E-04
ENSG00000130997	POLN	0.879	1.32E-03
ENSG00000060140	STYK1	0.878	1.61E-07
ENSG00000165494	PCF11	0.877	6.07E-18
ENSG00000069667	RORA	0.876	1.84E-06
ENSG00000104313	EYA1	0.875	1.07E-09
ENSG00000105856	HBP1	0.875	5.98E-15
ENSG00000162994	CLHC1	0.874	2.46E-06
ENSG00000180438	TPRXL	0.874	3.01E-04
ENSG00000119922	IFIT2	0.873	4.54E-15
ENSG00000247400	DNAJC3-AS1	0.873	7.50E-05
ENSG00000174500	GCSAM	0.873	2.01E-03
ENSG00000179168	GGN	0.873	5.46E-04
ENSG00000165115	KIF27	0.871	8.59E-09
ENSG00000188487	INSC	0.870	5.79E-03
ENSG00000187266	EPOR	0.870	1.07E-07
ENSG00000023839	ABCC2	0.868	2.48E-05
ENSG00000105371	ICAM4	0.865	1.61E-04
ENSG00000272168	CASC15	0.865	1.79E-05
ENSG00000171606	ZNF274	0.865	6.60E-16
ENSG00000170345	FOS	0.864	1.45E-17
ENSG00000172273	HINFP	0.863	2.85E-10

ENSG00000153982	GDPD1	0.862	2.68E-05
ENSG00000254726	MEX3A	0.861	1.24E-12
ENSG00000163602	RYBP	0.861	2.20E-15
ENSG00000241839	PLEKHO2	0.859	7.00E-12
ENSG00000169946	ZFPM2	0.859	1.47E-06
ENSG00000162733	DDR2	0.859	9.37E-09
ENSG00000184635	ZNF93	0.859	1.40E-07
ENSG00000187987	ZSCAN23	0.858	6.99E-05
ENSG00000162461	SLC25A34	0.857	1.68E-05
ENSG00000258701	LINC00638	0.857	8.16E-04
ENSG00000163053	SLC16A14	0.855	3.07E-08
ENSG00000186352	ANKRD37	0.855	8.98E-06
ENSG00000240429	LRRFIP1P1	0.854	4.40E-04
ENSG00000153714	LURAP1L	0.853	5.87E-07
ENSG00000134215	VAV3	0.851	2.92E-05
ENSG00000145390	USP53	0.850	4.28E-16
ENSG00000198774	RASSF9	0.850	2.50E-09
ENSG00000120370	GORAB	0.850	9.86E-10
ENSG00000007968	E2F2	0.849	9.01E-12
ENSG00000101306	MYLK2	0.846	8.25E-05
ENSG00000166450	PRTG	0.846	8.67E-04
ENSG00000168386	FILIP1L	0.844	8.25E-11
ENSG00000186280	KDM4D	0.841	1.83E-07
ENSG00000108506	INTS2	0.839	3.73E-13
ENSG00000143067	ZNF697	0.837	3.66E-14
ENSG00000151012	SLC7A11	0.835	5.28E-15
ENSG00000198185	ZNF334	0.834	9.54E-07
ENSG00000227354	RBM26-AS1	0.834	1.38E-06
ENSG00000247746	USP51	0.832	1.81E-04
ENSG00000125347	IRF1	0.831	2.41E-14
ENSG00000179750	APOBEC3B	0.831	8.94E-10
ENSG00000102057	KCND1	0.830	2.18E-07
ENSG00000109458	GAB1	0.827	4.42E-11
ENSG00000011422	PLAUR	0.827	2.03E-15
ENSG00000109046	WSB1	0.826	4.66E-15
ENSG00000174010	KLHL15	0.825	1.27E-11
ENSG00000128881	TTBK2	0.825	2.36E-15
ENSG00000160469	BRSK1	0.824	9.70E-06
ENSG00000179826	MRGPRX3	0.822	1.91E-10
ENSG00000168970	JMJD7-PLA2G4B	0.822	1.22E-03
ENSG00000048052	HDAC9	0.821	5.81E-09
ENSG00000139410	SDSL	0.820	9.76E-07
ENSG00000163644	PPM1K	0.820	2.37E-09

ENSG00000109846	CRYAB	0.819	5.69E-08
ENSG00000182308	DCAF4L1	0.819	3.12E-03
ENSG00000091656	ZFHX4	0.818	1.52E-07
ENSG00000119630	PGF	0.818	2.26E-10
ENSG00000105523	FAM83E	0.817	9.34E-03
ENSG00000117069	ST6GALNAC5	0.817	9.06E-05
ENSG00000132510	KDM6B	0.814	6.96E-15
ENSG00000263006	ROCK1P1	0.814	2.36E-03
ENSG00000197748	CFAP43	0.812	8.00E-04
ENSG00000279968	GVQW2	0.811	7.47E-03
ENSG00000127311	HELB	0.811	9.14E-08
ENSG00000032219	ARID4A	0.811	2.45E-12
ENSG00000188185	LINC00265	0.810	9.46E-09
ENSG00000280670	CCDC163P	0.809	2.47E-05
ENSG00000078699	CBFA2T2	0.809	5.75E-15
ENSG00000171631	P2RY6	0.808	5.18E-03
ENSG00000129028	THAP10	0.808	3.88E-08
ENSG00000198205	ZXDA	0.806	1.07E-05
ENSG00000132003	ZSWIM4	0.806	2.64E-13
ENSG00000135905	DOCK10	0.804	1.90E-03
ENSG00000142065	ZFP14	0.802	2.66E-04
ENSG00000226328	NUP50-AS1	0.802	1.25E-08
ENSG00000114019	AMOTL2	0.800	1.23E-14
ENSG00000119938	PPP1R3C	0.799	1.89E-07
ENSG00000134294	SLC38A2	0.799	4.36E-18
ENSG00000137834	SMAD6	0.798	1.38E-04
ENSG00000130164	LDLR	0.796	4.80E-17
ENSG00000131480	AOC2	0.796	4.02E-06
ENSG00000179454	KLHL28	0.796	4.42E-11
ENSG00000115616	SLC9A2	0.794	8.85E-04
ENSG00000244625	MIATNB	0.793	2.13E-03
ENSG00000164796	CSMD3	0.793	1.40E-04
ENSG00000164430	MB21D1	0.792	1.91E-14
ENSG00000176714	CCDC121	0.792	1.82E-03
ENSG00000028277	POU2F2	0.792	1.44E-04
ENSG00000180787	ZFP3	0.791	5.20E-09
ENSG00000142871	CYR61	0.790	7.57E-15
ENSG00000234444	ZNF736	0.790	7.65E-08
ENSG00000139354	GAS2L3	0.789	6.20E-12
ENSG00000204282	TNRC6C-AS1	0.788	3.75E-03
ENSG00000125378	BMP4	0.787	5.28E-05
ENSG00000164117	FBXO8	0.787	1.84E-08
ENSG00000170949	ZNF160	0.786	2.58E-12

ENSG00000131149	GSE1	0.785	1.99E-14
ENSG00000153721	CNKSR3	0.785	3.02E-07
ENSG00000149346	SLX4IP	0.785	1.04E-09
ENSG00000142867	BCL10	0.784	3.51E-14
ENSG00000112182	BACH2	0.784	9.85E-12
ENSG00000185862	EVI2B	0.784	1.93E-04
ENSG00000215908	CROCCP2	0.783	2.64E-11
ENSG00000198464	ZNF480	0.782	2.64E-11
ENSG00000197329	PELI1	0.782	1.21E-13
ENSG00000074047	GLI2	0.781	2.97E-04
ENSG00000108375	RNF43	0.781	6.89E-13
ENSG00000163637	PRICKLE2	0.780	7.43E-11
ENSG00000179532	DNHD1	0.780	6.02E-11
ENSG00000271614	LINC00936	0.779	1.51E-02
ENSG00000106479	ZNF862	0.779	2.21E-08
ENSG00000175564	UCP3	0.777	3.84E-03
ENSG00000204650	CRHR1-IT1	0.776	1.45E-07
ENSG00000164197	RNF180	0.775	6.65E-04
ENSG00000139438	FAM222A	0.775	2.19E-04
ENSG00000171169	NAIF1	0.774	7.34E-07
ENSG00000162148	PPP1R32	0.773	2.92E-03
ENSG00000168016	TRANK1	0.772	1.68E-07
ENSG00000178665	ZNF713	0.772	5.93E-05
ENSG00000198482	ZNF808	0.771	4.40E-08
ENSG00000163961	RNF168	0.771	5.91E-13
ENSG00000073910	FRY	0.769	5.80E-07
ENSG00000113739	STC2	0.768	2.30E-18
ENSG00000206337	HCP5	0.766	2.95E-09
ENSG00000109618	SEPSECS	0.766	8.48E-10
ENSG00000136158	SPRY2	0.765	3.42E-11
ENSG00000081320	STK17B	0.764	1.32E-13
ENSG00000164296	TIGD6	0.763	8.94E-10
ENSG00000197405	C5AR1	0.763	1.22E-05
ENSG00000165943	MOAP1	0.762	2.62E-10
ENSG00000148200	NR6A1	0.762	4.26E-05
ENSG00000237330	RNF223	0.761	7.82E-03
ENSG00000002016	RAD52	0.760	8.68E-08
ENSG00000171940	ZNF217	0.760	1.15E-17
ENSG00000229320	KRT8P12	0.759	2.62E-06
ENSG00000188659	SAXO2	0.758	1.10E-03
ENSG00000120647	CCDC77	0.758	5.03E-11
ENSG00000175895	PLEKHF2	0.757	9.68E-14
ENSG00000214226	C17orf67	0.757	7.40E-06

ENSG00000109906	ZBTB16	0.756	2.62E-09
ENSG00000196275	GTF2IRD2	0.754	1.58E-03
ENSG00000013441	CLK1	0.754	2.78E-14
ENSG00000132005	RFX1	0.753	4.93E-09
ENSG00000163660	CCNL1	0.751	3.17E-15
ENSG00000180573	HIST1H2AC	0.750	1.39E-08
ENSG00000258441	LINC00641	0.750	1.47E-09
ENSG00000163739	CXCL1	0.750	2.26E-14
ENSG00000217128	FNIP1	0.750	3.68E-14
ENSG00000152433	ZNF547	0.749	5.26E-03
ENSG00000136895	GARNL3	0.748	3.80E-05
ENSG00000111859	NEDD9	0.747	1.07E-11
ENSG00000109756	RAPGEF2	0.745	3.19E-13
ENSG00000137145	DENND4C	0.745	1.92E-14
ENSG00000143127	ITGA10	0.744	4.94E-05
ENSG00000256223	ZNF10	0.744	2.43E-05
ENSG00000152409	JMY	0.744	5.78E-12
ENSG00000106415	GLCCI1	0.743	1.02E-06
ENSG00000255398	HCAR3	0.743	3.09E-09
ENSG00000081041	CXCL2	0.743	1.35E-13
ENSG00000056277	ZNF280C	0.741	1.27E-09
ENSG00000239653	PSMD6-AS2	0.741	6.52E-04
ENSG00000197580	BCO2	0.740	9.35E-03
ENSG00000156030	ELMSAN1	0.740	6.96E-15
ENSG00000188215	DCUN1D3	0.739	4.73E-10
ENSG00000113742	CPEB4	0.738	1.10E-13
ENSG00000237296	SMG1P1	0.737	3.17E-03
ENSG00000143333	RGS16	0.736	7.41E-05
ENSG00000163884	KLF15	0.736	5.02E-04
ENSG00000161011	SQSTM1	0.735	5.11E-17
ENSG00000182600	C2orf82	0.735	4.14E-03
ENSG00000185947	ZNF267	0.735	1.52E-11
ENSG00000182782	HCAR2	0.735	2.82E-07
ENSG00000187678	SPRY4	0.735	1.08E-13
ENSG00000226752	PSMD5-AS1	0.733	1.42E-07
ENSG00000100625	SIX4	0.733	4.56E-11
ENSG00000147174	ACRC	0.733	3.74E-04
ENSG00000147118	ZNF182	0.732	9.79E-09
ENSG00000168795	ZBTB5	0.732	5.10E-13
ENSG00000156650	KAT6B	0.729	4.31E-14
ENSG00000154642	C21orf91	0.728	1.81E-10
ENSG00000159556	ISL2	0.728	1.04E-03
ENSG00000149212	SESN3	0.727	1.19E-12

ENSG00000145365	TIFA	0.727	1.62E-08
ENSG00000185420	SMYD3	0.726	5.95E-03
ENSG00000136881	BAAT	0.726	7.62E-03
ENSG00000005238	FAM214B	0.726	3.00E-13
ENSG00000163877	SNIP1	0.726	9.03E-13
ENSG00000184271	POU6F1	0.726	3.79E-04
ENSG00000164331	ANKRA2	0.726	3.75E-10
ENSG00000186212	SOWAHB	0.726	2.72E-03
ENSG00000233822	HIST1H2BN	0.725	1.20E-02
ENSG00000049192	ADAMTS6	0.725	4.56E-09
ENSG00000230795	HLA-K	0.725	1.05E-04
ENSG00000080298	RFX3	0.724	9.27E-08
ENSG00000102287	GABRE	0.724	2.83E-08
ENSG00000143772	ITPKB	0.723	4.34E-08
ENSG00000120868	APAF1	0.723	1.59E-11
ENSG00000162924	REL	0.722	7.27E-13
ENSG00000067082	KLF6	0.720	1.10E-16
ENSG00000167487	KLHL26	0.719	4.62E-07
ENSG00000162407	PLPP3	0.718	1.57E-06
ENSG00000184384	MAML2	0.718	2.46E-11
ENSG00000175426	PCSK1	0.717	9.14E-07
ENSG00000185920	PTCH1	0.716	1.52E-08
ENSG00000174130	TLR6	0.716	1.12E-05
ENSG00000185022	MAFF	0.716	2.44E-13
ENSG00000121104	FAM117A	0.715	1.02E-08
ENSG00000171522	PTGER4	0.713	1.03E-07
ENSG00000244479	OR2A1-AS1	0.712	2.83E-04
ENSG00000003400	CASP10	0.712	1.60E-05
ENSG00000132823	OSER1	0.712	3.05E-14
ENSG00000125319	C17orf53	0.711	2.38E-12
ENSG00000148483	TMEM236	0.710	4.45E-03
ENSG00000178385	PLEKHM3	0.709	1.05E-05
ENSG00000077063	CTTNBP2	0.709	2.72E-03
ENSG00000197779	ZNF81	0.708	1.15E-09
ENSG00000154153	FAM134B	0.708	3.21E-05
ENSG00000234814	SVILP1	0.707	1.37E-03
ENSG00000170365	SMAD1	0.706	3.13E-12
ENSG00000164823	OSGIN2	0.706	2.50E-13
ENSG00000179111	HES7	0.705	1.50E-08
ENSG00000103852	TTC23	0.705	9.91E-10
ENSG00000085276	MECOM	0.705	8.67E-09
ENSG00000119703	ZC2HC1C	0.705	2.63E-02
ENSG00000115137	DNAJC27	0.704	1.13E-06

ENSG00000112096	SOD2	0.704	1.22E-11
ENSG00000149050	ZNF214	0.703	5.81E-05
ENSG00000165312	OTUD1	0.703	2.40E-08
ENSG00000169330	KIAA1024	0.703	4.36E-04
ENSG00000132196	HSD17B7	0.703	3.88E-08
ENSG00000239883	PARGP1	0.702	3.42E-05
ENSG00000078900	TP73	0.702	2.19E-06
ENSG00000223891	OSER1-AS1	0.700	1.27E-03
ENSG00000042317	SPATA7	0.699	1.94E-06
ENSG00000148339	SLC25A25	0.698	2.51E-09
ENSG00000124508	BTN2A2	0.698	1.06E-08
ENSG00000109101	FOXN1	0.696	7.03E-03
ENSG00000135365	PHF21A	0.695	4.43E-13
ENSG00000155304	HSPA13	0.695	5.84E-11
ENSG00000145241	CENPC	0.694	6.00E-09
ENSG00000197808	ZNF461	0.694	7.91E-06
ENSG00000183621	ZNF438	0.694	1.54E-07
ENSG00000101670	LIPG	0.693	4.02E-12
ENSG00000070759	TESK2	0.693	5.56E-07
ENSG00000105464	GRIN2D	0.693	2.57E-04
ENSG00000188786	MTF1	0.693	2.84E-14
ENSG00000120217	CD274	0.692	4.31E-08
ENSG00000196911	KPNA5	0.691	1.39E-06
ENSG00000153487	ING1	0.691	6.37E-11
ENSG00000150907	FOXO1	0.691	1.17E-10
ENSG00000152527	PLEKHH2	0.691	6.51E-06
ENSG00000185133	INPP5J	0.691	3.12E-05
ENSG00000127666	TICAM1	0.690	7.43E-11
ENSG00000176771	NCKAP5	0.690	5.40E-04
ENSG00000152475	ZNF837	0.690	7.75E-03
ENSG00000074935	TUBE1	0.688	1.63E-10
ENSG00000186376	ZNF75D	0.687	4.24E-07
ENSG00000163216	SPRR2D	0.687	9.93E-03
ENSG00000105497	ZNF175	0.687	5.11E-08
ENSG00000167842	MIS12	0.685	2.14E-12
ENSG00000235944	ZNF815P	0.685	1.63E-03
ENSG00000171984	C20orf196	0.684	4.47E-04
ENSG00000245849	RAD51-AS1	0.683	4.25E-05
ENSG00000104447	TRPS1	0.682	7.05E-11
ENSG00000163995	ABLIM2	0.682	4.69E-03
ENSG00000104497	SNX16	0.682	3.32E-05
ENSG00000103723	AP3B2	0.681	3.46E-04
ENSG00000114859	CLCN2	0.681	4.70E-09

ENSG00000186010	NDUFA13	0.679	5.99E-03
ENSG00000110723	EXPH5	0.679	1.05E-08
ENSG00000160336	ZNF761	0.679	3.79E-09
ENSG00000182580	EPHB3	0.678	6.50E-06
ENSG00000025156	HSF2	0.678	1.93E-09
ENSG00000111860	CEP85L	0.678	6.26E-06
ENSG00000114541	FRMD4B	0.677	8.53E-16
ENSG00000182175	RGMA	0.677	4.70E-03
ENSG00000132950	ZMYM5	0.676	3.31E-10
ENSG00000143995	MEIS1	0.675	2.73E-08
ENSG00000184988	TMEM106A	0.675	2.13E-03
ENSG00000178093	TSSK6	0.675	2.98E-03
ENSG00000180953	ST20	0.675	8.76E-03
ENSG00000056558	TRAF1	0.675	2.36E-06
ENSG00000239887	C1orf226	0.675	2.58E-03
ENSG00000178852	EFCAB13	0.674	1.55E-03
ENSG00000157557	ETS2	0.674	4.04E-15
ENSG00000164442	CITED2	0.673	3.76E-11
ENSG00000112144	ICK	0.672	1.45E-10
ENSG00000132535	DLG4	0.671	7.79E-09
ENSG00000123810	B9D2	0.671	1.78E-03
ENSG00000105136	ZNF419	0.671	7.13E-05
ENSG00000164080	RAD54L2	0.671	2.61E-13
ENSG00000165113	GKAP1	0.670	3.15E-04
ENSG00000171224	C10orf35	0.670	3.98E-04
ENSG00000249740	OSMR-AS1	0.668	4.08E-02
ENSG00000135241	PNPLA8	0.668	3.34E-11
ENSG00000162946	DISC1	0.668	1.99E-05
ENSG00000196182	STK40	0.668	9.99E-13
ENSG00000152439	ZNF773	0.667	3.86E-04
ENSG00000187953	PMS2CL	0.667	1.51E-09
ENSG00000197971	MBP	0.667	2.61E-10
ENSG00000272556	GTF2IP13	0.666	2.69E-04
ENSG00000173198	CYSLTR1	0.666	3.32E-03
ENSG00000224660	SH3BP5-AS1	0.666	2.42E-06
ENSG00000176728	TTTY14	0.665	1.15E-02
ENSG00000182224	CYB5D1	0.665	9.12E-05
ENSG00000231784	DBIL5P	0.665	6.43E-03
ENSG00000147180	ZNF711	0.665	7.16E-06
ENSG00000135604	STX11	0.665	1.63E-04
ENSG00000100219	XBP1	0.664	9.39E-17
ENSG00000198039	ZNF273	0.664	8.08E-06
ENSG00000110693	SOX6	0.664	1.21E-03

ENSG00000124171	PARD6B	0.663	1.00E-05
ENSG00000077458	FAM76B	0.663	1.18E-11
ENSG00000215067	ALOX12-AS1	0.662	1.98E-02
ENSG00000197822	OCLN	0.662	9.10E-11
ENSG00000083307	GRHL2	0.661	5.77E-12
ENSG00000153094	BCL2L11	0.660	9.12E-10
ENSG00000175147	TMEM51-AS1	0.660	1.61E-02
ENSG00000165171	WBSCR27	0.659	1.42E-04
ENSG00000164663	USP49	0.659	1.41E-08
ENSG00000187951	ARHGAP11B	0.658	3.37E-12
ENSG00000181690	PLAG1	0.658	4.89E-09
ENSG00000158321	AUTS2	0.657	4.84E-11
ENSG00000054267	ARID4B	0.657	2.06E-12
ENSG00000213918	DNASE1	0.656	2.48E-07
ENSG00000196724	ZNF418	0.656	5.34E-03
ENSG00000127129	EDN2	0.656	3.06E-04
ENSG00000183150	GPR19	0.656	1.45E-05
ENSG00000179148	ALOXE3	0.656	2.19E-06
ENSG00000184949	FAM227A	0.655	1.15E-03
ENSG00000130775	THEMIS2	0.655	1.62E-04
ENSG00000170153	RNF150	0.655	4.98E-07
ENSG00000225973	PIGBOS1	0.652	1.07E-03
ENSG00000123066	MED13L	0.652	9.05E-15
ENSG00000055609	KMT2C	0.651	5.07E-15
ENSG00000214837	LINC01347	0.651	4.25E-05
ENSG00000143013	LMO4	0.651	3.14E-12
ENSG00000147883	CDKN2B	0.650	6.74E-12
ENSG00000171877	FRMD5	0.649	1.32E-03
ENSG00000085465	OVGP1	0.649	9.93E-04
ENSG00000188283	ZNF383	0.649	1.59E-05
ENSG00000166455	C16orf46	0.648	8.45E-03
ENSG00000170222	ADPRM	0.648	2.05E-05
ENSG00000113595	TRIM23	0.646	1.44E-07
ENSG00000161149	TUBA3FP	0.646	9.90E-03
ENSG00000120278	PLEKHG1	0.646	8.85E-03
ENSG00000196935	SRGAP1	0.646	1.31E-11
ENSG00000177191	B3GNT8	0.645	5.97E-03
ENSG00000188493	C19orf54	0.645	5.39E-08
ENSG00000123636	BAZ2B	0.645	5.08E-14
ENSG00000178917	ZNF852	0.645	2.07E-04
ENSG00000169118	CSNK1G1	0.644	3.24E-13
ENSG00000171132	PRKCE	0.644	1.07E-07
ENSG00000138640	FAM13A	0.642	4.28E-09

ENSG00000106571	GLI3	0.641	1.05E-11
ENSG00000176700	SCAND2P	0.641	3.53E-05
ENSG00000142677	IL22RA1	0.641	1.33E-07
ENSG00000140961	OSGIN1	0.641	2.09E-05
ENSG00000122861	PLAU	0.641	2.07E-14
ENSG00000162086	ZNF75A	0.641	6.35E-11
ENSG00000179299	NSUN7	0.640	7.42E-03
ENSG00000109381	ELF2	0.639	6.58E-12
ENSG00000185158	LRRC37B	0.638	1.56E-06
ENSG00000171295	ZNF440	0.638	1.25E-07
ENSG00000185215	TNFAIP2	0.638	9.51E-10
ENSG00000197008	ZNF138	0.637	1.44E-05
ENSG00000112796	ENPP5	0.636	9.29E-03
ENSG00000275340	FGD5P1	0.636	3.21E-04
ENSG00000101665	SMAD7	0.636	1.83E-10
ENSG00000081189	MEF2C	0.635	1.25E-04
ENSG00000232133	IMPDH1P10	0.635	1.87E-03
ENSG00000203965	EFCAB7	0.635	2.18E-07
ENSG00000166833	NAV2	0.635	2.63E-13
ENSG00000246922	UBAP1L	0.634	1.39E-04
ENSG00000184185	KCNJ12	0.634	9.34E-08
ENSG00000142675	CNKSR1	0.634	3.22E-11
ENSG00000070669	ASNS	0.633	1.86E-11
ENSG00000186496	ZNF396	0.633	2.17E-02
ENSG00000176531	PHLDB3	0.631	6.51E-06
ENSG00000169087	HSPBAP1	0.631	1.44E-07
ENSG00000147872	PLIN2	0.631	1.65E-08
ENSG00000152217	SETBP1	0.630	6.01E-10
ENSG00000071243	ING3	0.630	2.79E-08
ENSG00000222009	BTBD19	0.630	1.09E-07
ENSG00000148737	TCF7L2	0.629	3.42E-12
ENSG00000275066	SYNRG	0.628	6.87E-12
ENSG00000157554	ERG	0.628	7.93E-06
ENSG00000024862	CCDC28A	0.627	3.50E-06
ENSG00000176809	LRRC37A3	0.625	2.79E-03
ENSG00000206535	LNP1	0.625	4.07E-03
ENSG00000163806	SPDYA	0.624	2.83E-03
ENSG00000138193	PLCE1	0.624	1.61E-03
ENSG00000167785	ZNF558	0.624	5.25E-06
ENSG00000152457	DCLRE1C	0.624	7.93E-10
ENSG00000129353	SLC44A2	0.624	2.68E-15
ENSG00000151612	ZNF827	0.624	1.49E-10
ENSG00000172530	BANP	0.623	6.09E-08

ENSG00000133401	PDZD2	0.623	5.37E-11
ENSG00000022976	ZNF839	0.623	3.95E-08
ENSG00000264575	LINC00526	0.622	1.01E-02
ENSG00000153790	C7orf31	0.621	7.62E-07
ENSG00000087903	RFX2	0.621	3.69E-09
ENSG00000197019	SERTAD1	0.621	5.84E-11
ENSG00000174652	ZNF266	0.620	7.88E-08
ENSG00000105717	PBX4	0.620	1.15E-02
ENSG00000185869	ZNF829	0.620	5.28E-08
ENSG00000185267	CDNF	0.619	3.60E-03
ENSG00000175820	CCDC168	0.619	1.29E-02
ENSG00000104140	RHOV	0.618	5.89E-04
ENSG00000166004	CEP295	0.618	4.16E-12
ENSG00000059804	SLC2A3	0.618	1.94E-09
ENSG00000096654	ZNF184	0.617	4.37E-07
ENSG00000070190	DAPP1	0.617	2.62E-10
ENSG00000197714	ZNF460	0.617	1.57E-02
ENSG00000166483	WEE1	0.615	1.04E-09
ENSG00000169629	RGPD8	0.615	1.18E-02
ENSG00000254535	PABPC4L	0.615	1.54E-06
ENSG00000198108	CHSY3	0.615	2.73E-04
ENSG00000173451	THAP2	0.615	7.32E-07
ENSG00000104427	ZC2HC1A	0.614	1.08E-07
ENSG00000186907	RTN4RL2	0.614	3.36E-04
ENSG00000170836	PPM1D	0.614	1.22E-10
ENSG00000143344	RGL1	0.613	7.28E-07
ENSG00000164074	ABHD18	0.613	1.24E-08
ENSG00000111846	GCNT2	0.613	1.38E-02
ENSG00000197933	ZNF823	0.613	1.87E-04
ENSG00000243660	ZNF487	0.612	4.35E-04
ENSG00000173575	CHD2	0.612	1.69E-15
ENSG00000168769	TET2	0.612	3.10E-11
ENSG00000081665	ZNF506	0.611	3.00E-05
ENSG00000164136	IL15	0.611	8.16E-03
ENSG00000112972	HMGCS1	0.609	1.76E-15
ENSG00000108306	FBXL20	0.609	9.97E-09
ENSG00000142528	ZNF473	0.609	3.34E-11
ENSG00000162105	SHANK2	0.609	8.11E-05
ENSG00000125772	GPCPD1	0.608	2.57E-13
ENSG00000103269	RHBDL1	0.608	1.39E-02
ENSG00000115966	ATF2	0.608	1.28E-11
ENSG00000163362	C1orf106	0.607	4.87E-11
ENSG00000239213	NCK1-AS1	0.607	1.80E-03

ENSG00000196214	ZNF766	0.607	9.97E-07
ENSG00000162241	SLC25A45	0.606	5.46E-04
ENSG00000109265	KIAA1211	0.606	1.76E-04
ENSG00000089692	LAG3	0.605	2.48E-02
ENSG00000196437	ZNF569	0.605	5.36E-03
ENSG00000100439	ABHD4	0.604	8.79E-11
ENSG00000147121	KRBOX4	0.604	4.45E-06
ENSG00000067646	ZFY	0.603	7.30E-09
ENSG00000100842	EFS	0.602	1.19E-08
ENSG00000163864	NMNAT3	0.601	2.07E-02
ENSG00000105287	PRKD2	0.601	7.20E-12
ENSG00000113231	PDE8B	0.601	1.18E-02
ENSG00000213047	DENND1B	0.600	2.48E-07
ENSG00000260727	SLC7A5P1	0.600	2.89E-02
ENSG00000164379	FOXQ1	0.600	1.91E-07
ENSG00000198453	ZNF568	0.599	6.52E-06
ENSG00000165195	PIGA	0.599	1.19E-10
ENSG00000122641	INHBA	0.599	1.91E-11
ENSG00000134138	MEIS2	0.599	1.18E-06
ENSG00000167216	KATNAL2	0.598	2.99E-02
ENSG00000108423	TUBD1	0.598	5.03E-07
ENSG00000105483	CARD8	0.597	1.14E-06
ENSG00000197903	HIST1H2BK	0.597	3.89E-06
ENSG00000152503	TRIM36	0.596	1.51E-04
ENSG00000256229	ZNF486	0.596	1.48E-04
ENSG00000088854	C20orf194	0.596	8.25E-11
ENSG00000141298	SSH2	0.596	9.78E-12
ENSG00000158352	SHROOM4	0.596	1.91E-04
ENSG00000179909	ZNF154	0.594	1.59E-02
ENSG00000112763	BTN2A1	0.594	1.89E-11
ENSG00000173846	PLK3	0.594	6.12E-11
ENSG00000117616	RSRP1	0.593	3.34E-10
ENSG00000228544	CCDC183-AS1	0.593	4.95E-03
ENSG00000220205	VAMP2	0.592	1.63E-10
ENSG00000181035	SLC25A42	0.592	4.74E-05
ENSG00000184378	ACTRT3	0.592	3.62E-04
ENSG00000100739	BDKRB1	0.592	5.10E-03
ENSG00000139618	BRCA2	0.591	4.26E-13
ENSG00000183878	UTY	0.591	3.85E-07
ENSG00000127081	ZNF484	0.591	1.25E-05
ENSG00000274180	NATD1	0.590	3.42E-05
ENSG00000187609	EXD3	0.590	4.99E-05
ENSG00000102984	ZNF821	0.590	5.13E-04

ENSG00000078687	TNRC6C	0.590	6.23E-06
ENSG00000116668	SWT1	0.590	5.74E-04
ENSG00000196597	ZNF782	0.590	5.62E-06
ENSG00000196843	ARID5A	0.590	1.13E-07
ENSG00000135549	PKIB	0.590	2.22E-02
ENSG00000108599	AKAP10	0.590	2.83E-10
ENSG00000214050	FBXO16	0.589	7.47E-04
ENSG00000143434	SEMA6C	0.589	7.58E-04
ENSG00000082258	CCNT2	0.589	9.83E-11
ENSG00000100485	SOS2	0.588	4.02E-12
ENSG00000123473	STIL	0.588	5.91E-13
ENSG00000174738	NR1D2	0.588	9.68E-11
ENSG00000198718	FAM179B	0.587	1.22E-07
ENSG00000165997	ARL5B	0.586	1.79E-10
ENSG00000189319	FAM53B	0.585	6.29E-11
ENSG00000231205	ZNF826P	0.585	2.76E-03
ENSG00000176697	BDNF	0.585	2.20E-03
ENSG00000144893	MED12L	0.585	5.49E-03
ENSG00000176018	LYSMD3	0.584	2.16E-10
ENSG00000119138	KLF9	0.584	2.44E-11
ENSG00000167280	ENGASE	0.584	3.79E-08
ENSG00000218510	LINC00339	0.583	3.60E-04
ENSG00000130818	ZNF426	0.583	1.05E-08
ENSG00000089091	DZANK1	0.582	9.70E-05
ENSG00000187860	CCDC157	0.581	2.48E-04
ENSG00000182983	ZNF662	0.581	4.03E-04
ENSG00000112137	PHACTR1	0.581	3.87E-02
ENSG00000236810	TCEB3-AS1	0.580	2.89E-03
ENSG00000144426	NBEAL1	0.580	5.32E-10
ENSG00000196391	ZNF774	0.580	3.72E-05
ENSG00000136878	USP20	0.580	7.25E-09
ENSG00000186056	MATN1-AS1	0.580	2.05E-03
ENSG00000166963	MAP1A	0.580	5.17E-03
ENSG00000085185	BCORL1	0.579	3.02E-09
ENSG00000076555	ACACB	0.579	3.69E-05
ENSG00000158079	PTPDC1	0.579	3.59E-10
ENSG00000235374	SSR4P1	0.579	5.00E-02
ENSG00000137955	RABGGTB	0.578	2.26E-12
ENSG00000074964	ARHGEF10L	0.578	1.93E-04
ENSG00000138376	BARD1	0.578	5.28E-08
ENSG00000180357	ZNF609	0.577	3.65E-14
ENSG00000016082	ISL1	0.577	2.18E-03
ENSG00000120519	SLC10A7	0.577	7.89E-07

ENSG00000180769	WDFY3-AS2	0.577	7.17E-03
ENSG00000078246	TULP3	0.577	1.12E-10
ENSG00000186409	CCDC30	0.576	7.20E-03
ENSG00000096070	BRPF3	0.576	2.72E-12
ENSG00000151065	DCP1B	0.576	8.39E-08
ENSG00000183580	FBXL7	0.576	8.92E-06
ENSG00000135999	EPC2	0.576	1.04E-10
ENSG00000163661	PTX3	0.575	1.49E-05
ENSG00000167703	SLC43A2	0.575	1.25E-09
ENSG00000161609	CCDC155	0.575	1.68E-02
ENSG00000184897	H1FX	0.575	4.44E-10
ENSG00000167566	NCKAP5L	0.574	9.07E-11
ENSG00000245680	ZNF585B	0.574	2.18E-05
ENSG00000144369	FAM171B	0.573	4.73E-05
ENSG00000069493	CLEC2D	0.573	9.26E-04
ENSG00000180747	SMG1P3	0.573	2.26E-04
ENSG00000138380	CARF	0.573	1.25E-04
ENSG00000138411	HECW2	0.573	1.99E-04
ENSG00000250067	YJEFN3	0.572	1.50E-06
ENSG00000181666	HKR1	0.572	2.37E-09
ENSG00000105204	DYRK1B	0.572	2.57E-07
ENSG00000188428	BLOC1S5	0.570	5.39E-06
ENSG00000166750	SLFN5	0.570	5.61E-14
ENSG00000179981	TSHZ1	0.569	1.37E-07
ENSG00000107105	ELAVL2	0.569	1.21E-08
ENSG00000079435	LIPE	0.569	4.15E-07
ENSG00000166446	CDYL2	0.569	1.26E-08
ENSG00000168944	CEP120	0.568	3.42E-11
ENSG00000151117	TMEM86A	0.568	1.98E-02
ENSG00000157657	ZNF618	0.568	4.30E-10
ENSG00000096717	SIRT1	0.567	2.22E-10
ENSG00000082269	FAM135A	0.567	2.05E-10
ENSG00000107854	TNKS2	0.567	2.34E-13
ENSG00000205464	ATP6AP1L	0.566	5.60E-05
ENSG00000250903	GMDS-AS1	0.566	1.06E-02
ENSG00000187796	CARD9	0.566	1.03E-02
ENSG00000167528	ZNF641	0.566	9.21E-09
ENSG00000173275	ZNF449	0.566	6.15E-05
ENSG00000150637	CD226	0.565	6.66E-03
ENSG00000121207	LRAT	0.565	1.74E-03
ENSG00000106404	CLDN15	0.565	6.79E-05
ENSG00000134780	DAGLA	0.564	7.89E-03
ENSG00000148143	ZNF462	0.564	1.21E-11

ENSG00000204524	ZNF805	0.564	1.66E-04
ENSG00000138639	ARHGAP24	0.563	3.32E-08
ENSG00000163376	KBTBD8	0.563	1.02E-06
ENSG00000109944	C11orf63	0.563	1.68E-04
ENSG00000196569	LAMA2	0.563	8.62E-03
ENSG00000114698	PLSCR4	0.563	7.59E-04
ENSG00000172159	FRMD3	0.562	1.31E-02
ENSG00000127452	FBXL12	0.562	1.18E-08
ENSG00000168143	FAM83B	0.562	1.46E-11
ENSG00000186364	NUDT17	0.562	1.43E-03
ENSG00000182263	FIGN	0.562	1.41E-05
ENSG00000196639	HRH1	0.561	1.22E-11
ENSG00000132326	PER2	0.561	3.39E-10
ENSG00000137573	SULF1	0.561	6.34E-04
ENSG00000189298	ZKSCAN3	0.561	6.72E-05
ENSG00000121621	KIF18A	0.561	7.59E-10
ENSG00000186638	KIF24	0.561	2.86E-10
ENSG00000177200	CHD9	0.561	6.20E-14
ENSG00000196652	ZKSCAN5	0.560	3.48E-11
ENSG00000143476	DTL	0.560	7.51E-14
ENSG00000196152	ZNF79	0.560	2.89E-05
ENSG00000136149	RPL13AP25	0.560	4.68E-02
ENSG00000115421	PAPOLG	0.560	1.99E-09
ENSG00000135968	GCC2	0.559	1.83E-11
ENSG00000162981	FAM84A	0.559	1.18E-05
ENSG00000063176	SPHK2	0.559	9.49E-08
ENSG00000081181	ARG2	0.559	2.82E-10
ENSG00000177337	DLGAP1-AS1	0.559	3.60E-03
ENSG00000116141	MARK1	0.558	7.04E-07
ENSG00000166578	IQCD	0.558	3.53E-03
ENSG00000139163	ETNK1	0.558	9.68E-08
ENSG00000151883	PARP8	0.558	3.87E-09
ENSG00000177294	FBXO39	0.558	2.88E-02
ENSG00000151151	IPMK	0.557	2.66E-08
ENSG00000169239	CA5B	0.557	4.85E-05
ENSG00000198723	C19orf45	0.557	5.04E-02
ENSG00000109787	KLF3	0.556	2.60E-12
ENSG00000185453	C19orf68	0.556	7.98E-07
ENSG00000109743	BST1	0.556	3.35E-02
ENSG00000118518	RNF146	0.556	7.31E-09
ENSG00000116991	SIPA1L2	0.556	1.87E-09
ENSG00000176472	ZNF575	0.555	3.69E-02
ENSG00000135205	CCDC146	0.555	1.19E-03

ENSG00000130522	JUND	0.555	5.82E-11
ENSG00000187790	FANCM	0.555	5.97E-08
ENSG00000185880	TRIM69	0.555	4.11E-08
ENSG00000143367	TUFT1	0.555	3.53E-11
ENSG00000141582	CBX4	0.555	2.94E-11
ENSG00000196814	MVB12B	0.554	4.36E-02
ENSG00000185436	IFNLR1	0.553	4.20E-07
ENSG00000272886	DCP1A	0.553	5.68E-12
ENSG00000105639	JAK3	0.553	2.63E-02
ENSG00000138688	KIAA1109	0.552	1.57E-12
ENSG00000083838	ZNF446	0.551	2.51E-04
ENSG00000000457	SCYL3	0.551	4.45E-07
ENSG00000117226	GBP3	0.551	3.01E-09
ENSG00000169193	CCDC126	0.550	7.79E-04
ENSG00000170835	CEL	0.549	2.28E-02
ENSG00000099958	DERL3	0.549	8.05E-04
ENSG00000135164	DMTF1	0.549	1.52E-12
ENSG00000107372	ZFAND5	0.549	1.02E-11
ENSG00000156976	EIF4A2	0.549	1.11E-12
ENSG00000188681	TEKT4P2	0.549	1.58E-02
ENSG00000204604	ZNF468	0.548	6.28E-08
ENSG00000111011	RSRC2	0.548	7.37E-14
ENSG00000278318	ZNF229	0.547	4.78E-06
ENSG00000135736	CCDC102A	0.546	1.45E-03
ENSG00000008086	CDKL5	0.546	3.50E-09
ENSG00000135540	NHSL1	0.546	5.87E-10
ENSG00000183604	SMG1P5	0.546	1.62E-02
ENSG00000163359	COL6A3	0.546	3.89E-02
ENSG00000116717	GADD45A	0.545	2.51E-12
ENSG00000179094	PER1	0.545	1.98E-12
ENSG00000147050	KDM6A	0.545	1.65E-10
ENSG00000204789	ZNF204P	0.545	2.56E-04
ENSG00000070495	JMJD6	0.544	5.05E-10
ENSG00000157796	WDR19	0.543	2.98E-09
ENSG00000198169	ZNF251	0.543	5.02E-06
ENSG00000154451	GBP5	0.543	7.08E-04
ENSG00000170852	KBTBD2	0.543	5.70E-12
ENSG00000088451	TGDS	0.543	1.09E-06
ENSG00000204138	PHACTR4	0.541	9.54E-13
ENSG00000164920	OSR2	0.541	5.39E-04
ENSG00000159082	SYNJ1	0.541	2.05E-10
ENSG00000156050	FAM161B	0.540	3.08E-05
ENSG00000240230	COX19	0.540	8.84E-10

ENSG00000157450	RNF111	0.540	4.45E-12
ENSG00000129514	FOXA1	0.539	5.73E-08
ENSG00000146872	TLK2	0.539	1.45E-11
ENSG00000182010	RTKN2	0.539	2.79E-03
ENSG00000095585	BLNK	0.538	4.50E-03
ENSG00000169902	TPST1	0.538	6.32E-08
ENSG00000117625	RCOR3	0.537	4.44E-10
ENSG00000011021	CLCN6	0.537	1.39E-09
ENSG00000260231	JHDM1D-AS1	0.537	1.74E-04
ENSG00000147894	C9orf72	0.537	1.72E-06
ENSG00000164284	GRPEL2	0.537	1.63E-10
ENSG00000212694	LINC01089	0.537	2.85E-04
ENSG00000112624	GLTSCR1L	0.537	1.64E-07
ENSG00000154447	SH3RF1	0.537	1.89E-09
ENSG00000129566	TEP1	0.536	3.40E-10
ENSG00000100209	HSCB	0.536	2.16E-04
ENSG00000159433	STARD9	0.535	1.91E-07
ENSG00000186812	ZNF397	0.534	2.51E-08
ENSG00000227124	ZNF717	0.534	1.92E-04
ENSG00000123411	IKZF4	0.534	4.80E-06
ENSG00000186532	SMYD4	0.534	2.60E-09
ENSG00000172006	ZNF554	0.534	3.32E-04
ENSG00000121440	PDZRN3	0.533	9.24E-04
ENSG00000141527	CARD14	0.533	3.78E-02
ENSG00000145868	FBXO38	0.533	3.09E-12
ENSG00000135749	PCNXL2	0.533	8.33E-10
ENSG00000181126	HLA-V	0.533	1.47E-06
ENSG00000196369	SRGAP2B	0.533	7.81E-08
ENSG00000006062	MAP3K14	0.533	1.50E-10
ENSG00000256683	ZNF350	0.533	1.17E-04
ENSG00000184863	RBM33	0.532	4.10E-13
ENSG00000080031	PTPRH	0.532	9.26E-03
ENSG00000052126	PLEKHA5	0.531	6.16E-12
ENSG00000133247	SUV420H2	0.530	7.40E-06
ENSG00000078725	BRINP1	0.530	7.35E-03
ENSG00000186615	KTN1-AS1	0.530	4.34E-03
ENSG00000101493	ZNF516	0.529	1.93E-08
ENSG00000120539	MASTL	0.529	7.41E-12
ENSG00000204934	ATP6V0E2-AS1	0.528	2.76E-02
ENSG00000163617	CCDC191	0.528	3.87E-04
ENSG00000173875	ZNF791	0.528	5.66E-11
ENSG00000159733	ZFYVE28	0.527	1.48E-02
ENSG00000153914	SREK1	0.527	8.45E-13

ENSG00000121274	PAPD5	0.527	1.08E-08
ENSG00000133302	SLF1	0.526	2.86E-09
ENSG00000250571	GLI4	0.526	5.16E-04
ENSG00000129521	EGLN3	0.526	3.94E-05
ENSG00000186448	ZNF197	0.526	7.77E-08
ENSG00000100802	C14orf93	0.525	4.25E-07
ENSG00000168310	IRF2	0.525	2.62E-09
ENSG00000102805	CLN5	0.525	1.71E-08
ENSG00000160223	ICOSLG	0.524	3.13E-03
ENSG00000135913	USP37	0.524	1.65E-11
ENSG00000167333	TRIM68	0.524	8.67E-07
ENSG00000177169	ULK1	0.523	2.68E-09
ENSG00000163393	SLC22A15	0.523	1.34E-08
ENSG00000101298	SNPH	0.522	7.96E-05
ENSG00000204428	LY6G5C	0.522	3.47E-02
ENSG00000111879	FAM184A	0.522	6.15E-03
ENSG00000153975	ZUFSP	0.522	3.26E-08
ENSG00000188158	NHS	0.521	4.62E-08
ENSG00000184898	RBM43	0.521	5.60E-05
ENSG00000183281	PLGLB1	0.521	3.30E-02
ENSG00000196296	ATP2A1	0.521	7.52E-04
ENSG00000155980	KIF5A	0.521	5.03E-03
ENSG00000183735	TBK1	0.520	1.18E-10
ENSG00000196081	ZNF724P	0.520	1.21E-03
ENSG00000146350	TBC1D32	0.520	3.00E-04
ENSG00000167771	RCOR2	0.520	3.60E-02
ENSG00000206417	H1FX-AS1	0.520	9.04E-03
ENSG00000213468	FIRRE	0.519	2.03E-02
ENSG00000235109	ZSCAN31	0.519	4.70E-03
ENSG00000205659	LIN52	0.519	6.19E-08
ENSG00000168137	SETD5	0.519	2.39E-13
ENSG00000137502	RAB30	0.519	7.64E-07
ENSG00000135503	ACVR1B	0.518	7.24E-11
ENSG00000134909	ARHGAP32	0.518	2.15E-11
ENSG00000135740	SLC9A5	0.517	2.53E-04
ENSG00000067715	SYT1	0.516	1.32E-02
ENSG00000179817	MRGPRX4	0.516	1.75E-02
ENSG00000163312	HELQ	0.516	6.79E-07
ENSG00000187091	PLCD1	0.516	1.72E-07
ENSG00000110851	PRDM4	0.516	6.09E-12
ENSG00000146410	MTFR2	0.516	5.38E-07
ENSG00000013392	RWDD2A	0.516	1.86E-04
ENSG00000222047	C10orf55	0.515	1.78E-02

ENSG00000104221	BRF2	0.515	5.08E-06
ENSG00000228696	ARL17B	0.515	2.37E-02
ENSG00000115183	TANC1	0.515	4.52E-13
ENSG00000006468	ETV1	0.514	2.16E-04
ENSG00000197863	ZNF790	0.513	1.63E-04
ENSG00000007944	MYLIP	0.513	3.32E-04
ENSG00000189079	ARID2	0.513	2.72E-11
ENSG00000197872	FAM49A	0.513	9.51E-03
ENSG00000138593	SECISBP2L	0.513	1.25E-09
ENSG00000214212	C19orf38	0.513	1.31E-02
ENSG00000227398	KIF9-AS1	0.513	6.06E-04
ENSG00000172671	ZFAND4	0.513	2.70E-04
ENSG00000165434	PGM2L1	0.512	4.83E-07
ENSG00000114423	CBLB	0.512	5.26E-08
ENSG00000077684	JADE1	0.512	3.91E-09
ENSG00000258900	HNRNPCP1	0.512	2.82E-02
ENSG00000081386	ZNF510	0.511	7.64E-09
ENSG00000188522	FAM83G	0.511	2.62E-12
ENSG00000139679	LPAR6	0.510	1.04E-03
ENSG00000134324	LPIN1	0.509	3.82E-12
ENSG00000109063	MYH3	0.509	7.69E-03
ENSG00000118922	KLF12	0.509	1.36E-08
ENSG00000114812	VIPR1	0.509	2.83E-02
ENSG00000280587	LINC01348	0.508	4.58E-02
ENSG00000184224	C11orf72	0.508	3.66E-03
ENSG00000204576	PRR3	0.508	2.74E-08
ENSG00000248905	FMN1	0.508	1.39E-03
ENSG00000080824	HSP90AA1	0.508	4.64E-14
ENSG00000168564	CDKN2AIP	0.508	2.75E-09
ENSG00000165185	KIAA1958	0.508	1.06E-05
ENSG00000198208	RPS6KL1	0.508	1.01E-03
ENSG00000203326	ZNF525	0.508	1.68E-06
ENSG00000116604	MEF2D	0.507	3.03E-10
ENSG00000155592	ZKSCAN2	0.507	1.79E-07
ENSG00000178694	NSUN3	0.505	1.89E-06
ENSG00000102908	NFAT5	0.505	9.78E-11
ENSG00000187098	MITF	0.505	7.41E-05
ENSG00000165246	NLGN4Y	0.505	2.72E-06
ENSG00000162783	IER5	0.505	8.79E-11
ENSG00000112186	CAP2	0.504	9.70E-05
ENSG00000128564	VGF	0.504	1.82E-03
ENSG00000134259	NGF	0.504	2.11E-02
ENSG00000205268	PDE7A	0.503	5.24E-09

ENSG00000116574	RHOU	0.503	1.51E-02
ENSG00000204685	STARD7-AS1	0.503	2.38E-03
ENSG00000179715	PCED1B	0.503	4.48E-05
ENSG00000178764	ZHX2	0.503	1.45E-07
ENSG00000092871	RFFL	0.503	1.22E-07
ENSG00000109220	CHIC2	0.503	2.05E-07
ENSG00000129749	CHRNA10	0.503	1.83E-02
ENSG00000197841	ZNF181	0.502	2.02E-04
ENSG00000231721	LINC-PINT	0.502	1.44E-02
ENSG00000129472	RAB2B	0.501	7.38E-08
ENSG00000216937	CCDC7	0.501	1.57E-02
ENSG00000245532	NEAT1	0.500	2.33E-07
ENSG00000068305	MEF2A	0.500	1.14E-10
ENSG00000176928	GCNT4	0.499	7.52E-04
ENSG00000135315	CEP162	0.499	2.96E-06
ENSG00000172869	DMXL1	0.499	1.50E-10
ENSG00000086061	DNAJA1	0.499	1.41E-12
ENSG00000213516	RBMXL1	0.498	6.43E-10
ENSG00000119042	SATB2	0.498	5.17E-06
ENSG00000144935	TRPC1	0.498	3.92E-06
ENSG00000170776	AKAP13	0.498	3.13E-12
ENSG00000186666	BCDIN3D	0.498	4.54E-04
ENSG00000177045	SIX5	0.497	1.78E-09
ENSG00000162852	CNST	0.497	9.79E-09
ENSG00000014914	MTMR11	0.497	1.43E-06
ENSG00000136866	ZFP37	0.497	7.89E-04
ENSG00000138658	ZGRF1	0.497	1.70E-08
ENSG00000148832	PAOX	0.497	1.36E-02
ENSG00000188763	FZD9	0.496	4.35E-02
ENSG00000196387	ZNF140	0.496	6.48E-07
ENSG00000124496	TRERF1	0.496	2.72E-11
ENSG00000143630	HCN3	0.496	4.32E-04
ENSG00000103995	CEP152	0.496	6.57E-09
ENSG00000222011	FAM185A	0.496	2.30E-05
ENSG00000251369	ZNF550	0.495	1.97E-05
ENSG00000173068	BNC2	0.495	3.19E-02
ENSG00000226067	LINC00623	0.494	4.73E-03
ENSG00000127507	ADGRE2	0.494	3.50E-02
ENSG00000001460	STPG1	0.494	7.68E-09
ENSG00000198382	UVRAG	0.494	1.85E-08
ENSG00000160908	ZNF394	0.493	1.54E-07
ENSG00000100852	ARHGAP5	0.493	1.46E-11
ENSG00000105227	PRX	0.493	8.98E-03

ENSG00000121690	DEPDC7	0.492	2.19E-05
ENSG00000213799	ZNF845	0.492	5.04E-06
ENSG00000185278	ZBTB37	0.492	9.59E-08
ENSG00000106546	AHR	0.491	5.53E-11
ENSG00000019485	PRDM11	0.491	1.31E-05
ENSG00000130856	ZNF236	0.491	2.66E-08
ENSG00000164061	BSN	0.491	3.31E-02
ENSG00000164741	DLC1	0.490	4.28E-08
ENSG00000176102	CSTF3	0.490	2.15E-10
ENSG00000128891	C15orf57	0.490	5.45E-06
ENSG00000116497	S100PBP	0.489	1.25E-09
ENSG00000121903	ZSCAN20	0.489	4.51E-05
ENSG00000182752	PAPPA	0.489	6.15E-07
ENSG00000112242	E2F3	0.489	6.86E-11
ENSG00000145780	FEM1C	0.488	2.04E-10
ENSG00000272645	GTF2IP20	0.488	7.29E-05
ENSG00000118620	ZNF430	0.488	9.67E-07
ENSG00000183914	DNAH2	0.487	1.60E-02
ENSG00000178878	APOLD1	0.487	7.75E-05
ENSG00000175105	ZNF654	0.487	1.38E-06
ENSG00000184402	SS18L1	0.487	1.27E-10
ENSG00000140396	NCOA2	0.487	3.36E-09
ENSG00000176024	ZNF613	0.487	4.40E-04
ENSG00000164118	CEP44	0.486	2.49E-05
ENSG00000155324	GRAMD3	0.486	1.89E-09
ENSG00000038295	TLL1	0.486	6.43E-05
ENSG00000112406	HECA	0.486	1.57E-08
ENSG00000256667	KLRAP1	0.485	2.98E-02
ENSG00000245060	LINC00847	0.485	4.19E-05
ENSG00000176046	NUPR1	0.485	4.76E-08
ENSG00000068745	IP6K2	0.485	2.83E-11
ENSG00000215421	ZNF407	0.485	2.15E-07
ENSG00000180423	HARBI1	0.485	3.17E-03
ENSG00000247708	STX18-AS1	0.484	8.01E-04
ENSG00000174501	ANKRD36C	0.484	5.39E-04
ENSG00000132906	CASP9	0.484	2.49E-04
ENSG00000104957	CCDC130	0.484	2.92E-07
ENSG00000189060	H1F0	0.484	2.10E-14
ENSG00000115904	SOS1	0.484	7.00E-11
ENSG00000153391	INO80C	0.483	3.56E-07
ENSG00000196812	ZSCAN16	0.483	2.62E-03
ENSG00000271503	CCL5	0.483	7.63E-04
ENSG00000179523	EIF3J-AS1	0.483	3.68E-05

ENSG00000175395	ZNF25	0.483	1.48E-04
ENSG00000129810	SGOL1	0.483	4.21E-08
ENSG00000154114	TBCEL	0.483	6.96E-07
ENSG00000242028	HYPK	0.483	1.44E-02
ENSG00000090975	PITPNM2	0.482	1.29E-06
ENSG00000179021	C3orf38	0.482	4.03E-09
ENSG00000204438	GPANK1	0.482	9.68E-09
ENSG00000183475	ASB7	0.482	2.57E-08
ENSG00000162927	PUS10	0.482	5.31E-04
ENSG00000234127	TRIM26	0.482	1.46E-11
ENSG00000198538	ZNF28	0.481	3.22E-06
ENSG00000143622	RIT1	0.481	5.17E-09
ENSG00000120696	KBTBD7	0.481	3.10E-06
ENSG00000113504	SLC12A7	0.481	1.32E-08
ENSG00000196922	ZNF252P	0.480	8.13E-09
ENSG00000260852	FBXL19-AS1	0.480	1.98E-03
ENSG00000111785	RIC8B	0.480	5.03E-07
ENSG00000130544	ZNF557	0.479	6.33E-06
ENSG00000005483	KMT2E	0.479	7.04E-12
ENSG00000062716	VMP1	0.479	1.42E-11
ENSG00000132205	EMILIN2	0.478	1.11E-02
ENSG00000155760	FZD7	0.478	7.33E-05
ENSG00000198873	GRK5	0.478	2.01E-05
ENSG00000105866	SP4	0.478	3.68E-07
ENSG00000180229	HERC2P3	0.477	4.03E-03
ENSG00000197062	ZSCAN26	0.477	2.18E-05
ENSG00000111961	SASH1	0.477	9.59E-08
ENSG00000169379	ARL13B	0.477	8.32E-08
ENSG00000119866	BCL11A	0.477	4.07E-05
ENSG00000138468	SENP7	0.477	4.47E-06
ENSG00000150667	FSIP1	0.476	2.32E-02
ENSG00000139517	LNX2	0.476	4.91E-10
ENSG00000213020	ZNF611	0.476	5.07E-04
ENSG00000135951	TSGA10	0.476	9.07E-03
ENSG00000189212	DPY19L2P1	0.475	3.61E-03
ENSG00000255571	MIR9-3HG	0.475	1.25E-04
ENSG00000204516	MICB	0.475	6.92E-10
ENSG00000124177	CHD6	0.474	5.77E-12
ENSG00000115020	PIKFYVE	0.474	7.32E-10
ENSG00000198346	ZNF813	0.473	7.93E-06
ENSG00000115556	PLCD4	0.473	1.09E-02
ENSG00000079308	TNS1	0.473	9.48E-07
ENSG00000126016	AMOT	0.473	1.47E-02

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ENSG00000008323	PLEKHG6	0.471	1.76E-02
ENSG00000244405	ETV5	0.471	1.10E-07
ENSG00000163795	ZNF513	0.471	3.56E-07
ENSG00000124587	PEX6	0.470	5.30E-03
ENSG00000197299	BLM	0.469	1.15E-09
ENSG00000124257	NEURL2	0.469	8.39E-03
ENSG00000140941	MAP1LC3B	0.468	4.17E-12
ENSG00000181274	FRAT2	0.468	7.36E-07
ENSG00000163435	ELF3	0.468	3.19E-03
ENSG00000103657	HERC1	0.468	1.46E-09
ENSG00000170412	GPRC5C	0.468	1.72E-03
ENSG00000170653	ATF7	0.467	8.32E-10
ENSG00000048649	RSF1	0.467	1.85E-11
ENSG00000118197	DDX59	0.467	1.18E-07
ENSG00000155111	CDK19	0.467	8.18E-08
ENSG00000135378	PRRG4	0.466	2.54E-09
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ENSG00000088305	DNMT3B	0.466	4.33E-05
ENSG00000151474	FRMD4A	0.466	4.69E-07
ENSG00000106261	ZKSCAN1	0.465	2.60E-11
ENSG00000089060	SLC8B1	0.464	7.83E-08
ENSG00000266028	SRGAP2	0.464	1.46E-10
ENSG00000160602	NEK8	0.464	7.73E-05
ENSG00000181982	CCDC149	0.462	3.41E-03
ENSG00000176182	MYPOP	0.462	8.75E-05
ENSG00000163635	ATXN7	0.461	3.49E-11
ENSG00000179588	ZFPM1	0.461	1.55E-03
ENSG00000110497	AMBRA1	0.461	1.08E-09
ENSG00000188322	SBK1	0.461	1.96E-02
ENSG00000102543	CDADC1	0.461	1.85E-05
ENSG00000179406	LINC00174	0.460	9.09E-04
ENSG00000083097	DOPEY1	0.460	3.80E-07
ENSG00000185015	CA13	0.459	5.74E-05
ENSG00000139190	VAMP1	0.459	4.43E-03
ENSG00000185697	MYBL1	0.459	4.64E-08
ENSG00000101255	TRIB3	0.458	1.07E-11
ENSG00000109654	TRIM2	0.458	1.52E-04
ENSG00000152454	ZNF256	0.458	5.13E-03
ENSG00000149308	NPAT	0.458	3.72E-10
ENSG00000214293	APTR	0.457	3.86E-04
ENSG00000092978	GPATCH2	0.457	6.01E-08
ENSG00000101745	ANKRD12	0.457	1.13E-09

ENSG00000130338	TULP4	0.456	4.72E-09
ENSG00000140386	SCAPER	0.456	3.94E-06
ENSG00000143384	MCL1	0.455	3.65E-14
ENSG00000175764	TTLL11	0.455	3.41E-07
ENSG00000115548	KDM3A	0.455	2.58E-10
ENSG00000038382	TRIO	0.455	3.00E-11
ENSG00000258708	SLC25A21-AS1	0.454	1.96E-02
ENSG00000088179	PTPN4	0.454	1.14E-07
ENSG00000214174	AMZ2P1	0.454	1.03E-02
ENSG00000189143	CLDN4	0.454	4.86E-05
ENSG00000084731	KIF3C	0.453	1.98E-07
ENSG00000160953	MUM1	0.453	3.91E-08
ENSG00000128512	DOCK4	0.453	3.26E-07
ENSG00000141449	GREB1L	0.453	2.87E-06
ENSG00000130803	ZNF317	0.452	2.23E-10
ENSG00000198160	MIER1	0.452	1.20E-09
ENSG00000139675	HNRNPA1L2	0.452	1.36E-04
ENSG00000177888	ZBTB41	0.452	6.09E-06
ENSG00000095752	IL11	0.452	3.44E-04
ENSG00000115009	CCL20	0.451	6.81E-07
ENSG00000119943	PYROXD2	0.451	4.19E-02
ENSG00000137075	RNF38	0.451	5.17E-08
ENSG00000164542	KIAA0895	0.451	1.98E-05
ENSG00000101577	LPIN2	0.450	4.91E-07
ENSG00000117318	ID3	0.450	1.40E-09
ENSG00000204623	ZNRD1-AS1	0.450	4.26E-05
ENSG00000178860	MSC	0.450	1.52E-02
ENSG00000158636	C11orf30	0.450	1.91E-10
ENSG00000149257	SERPINH1	0.449	1.43E-12
ENSG00000095397	DFNB31	0.449	8.05E-04
ENSG00000107882	SUFU	0.449	1.14E-07
ENSG00000031691	CENPQ	0.449	1.72E-06
ENSG00000187624	C17orf97	0.448	1.05E-02
ENSG00000167207	NOD2	0.448	1.78E-02
ENSG00000177000	MTHFR	0.448	1.35E-07
ENSG00000166206	GABRB3	0.447	4.49E-02
ENSG00000104369	JPH1	0.447	1.09E-04
ENSG00000076650	GPATCH1	0.446	1.12E-06
ENSG00000204257	HLA-DMA	0.446	1.79E-02
ENSG00000153814	JAZF1	0.446	7.37E-06
ENSG00000033327	GAB2	0.446	2.08E-04
ENSG00000151746	BICD1	0.446	1.21E-07
ENSG00000161277	THAP8	0.446	4.00E-02

ENSG00000108557	RAI1	0.445	1.09E-09
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ENSG00000166822	TMEM170A	0.445	3.90E-07
ENSG00000132952	USPL1	0.445	2.28E-07
ENSG00000107077	KDM4C	0.445	7.10E-06
ENSG00000063169	GLTSCR1	0.445	2.79E-06
ENSG00000204172	AGAP9	0.445	2.74E-03
ENSG00000075420	FNDC3B	0.444	4.11E-12
ENSG00000112200	ZNF451	0.444	1.27E-09
ENSG00000188610	FAM72B	0.444	3.37E-06
ENSG00000196247	ZNF107	0.443	7.56E-07
ENSG00000139793	MBNL2	0.443	1.02E-07
ENSG00000147905	ZCCHC7	0.443	2.23E-09
ENSG00000145632	PLK2	0.443	9.85E-09
ENSG00000174799	CEP135	0.443	1.53E-07
ENSG00000234420	ZNF37BP	0.443	8.46E-07
ENSG00000134874	DZIP1	0.443	2.94E-08
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ENSG00000105072	C19orf44	0.442	2.08E-04
ENSG00000114933	INO80D	0.442	2.16E-09
ENSG00000129696	TTI2	0.442	2.09E-05
ENSG00000239521	GATS	0.442	1.60E-02
ENSG00000153046	CDYL	0.441	1.23E-10
ENSG00000186017	ZNF566	0.441	8.12E-04
ENSG00000225465	RFPL1S	0.441	4.62E-05
ENSG00000178573	MAF	0.441	6.51E-03
ENSG00000176532	PRR15	0.440	9.51E-03
ENSG00000088756	ARHGAP28	0.440	1.24E-02
ENSG00000177683	THAP5	0.439	3.18E-09
ENSG00000260083	MIR762HG	0.439	4.58E-02
ENSG00000083799	CYLD	0.439	2.96E-10
ENSG00000196663	TECPR2	0.439	2.63E-07
ENSG00000158966	CACHD1	0.439	4.15E-05
ENSG00000223546	LINC00630	0.439	4.26E-03
ENSG00000273559	CWC25	0.438	1.88E-09
ENSG00000189190	ZNF600	0.438	3.69E-04
ENSG00000137871	ZNF280D	0.438	7.84E-08
ENSG00000198521	ZNF43	0.438	4.15E-03
ENSG00000106804	C5	0.438	3.68E-03
ENSG00000182986	ZNF320	0.437	4.17E-04
ENSG00000166024	R3HCC1L	0.437	9.59E-08
ENSG00000115998	C2orf42	0.437	2.16E-05
ENSG00000177463	NR2C2	0.437	1.61E-10

ENSG00000059145	UNKL	0.436	3.91E-06
ENSG00000182463	TSHZ2	0.435	1.99E-03
ENSG00000168497	SDPR	0.435	4.28E-05
ENSG00000161551	ZNF577	0.435	1.35E-04
ENSG00000133639	BTG1	0.435	4.65E-09
ENSG00000141219	C17orf80	0.435	1.48E-07
ENSG00000196998	WDR45	0.435	9.11E-05
ENSG00000130529	TRPM4	0.434	1.13E-05
ENSG00000162645	GBP2	0.434	2.13E-03
ENSG00000160094	ZNF362	0.434	1.03E-06
ENSG00000176406	RIMS2	0.434	3.71E-06
ENSG00000181827	RFX7	0.434	1.91E-10
ENSG00000156273	BACH1	0.433	9.11E-10
ENSG00000170456	DENND5B	0.433	1.30E-06
ENSG00000196632	WNK3	0.433	1.34E-04
ENSG00000186567	CEACAM19	0.433	9.75E-06
ENSG00000240038	AMY2B	0.433	1.31E-02
ENSG00000142556	ZNF614	0.432	6.66E-06
ENSG00000114790	ARHGEF26	0.432	5.33E-04
ENSG00000118058	KMT2A	0.432	1.46E-10
ENSG00000196550	FAM72A	0.432	2.39E-04
ENSG00000147799	ARHGAP39	0.432	1.24E-03
ENSG00000168014	C2CD3	0.432	1.41E-08
ENSG00000103150	MLYCD	0.430	6.69E-03
ENSG00000196123	KIAA0895L	0.430	1.01E-05
ENSG00000160352	ZNF714	0.430	1.46E-06
ENSG00000159167	STC1	0.430	1.15E-05
ENSG00000178974	FBXO34	0.430	2.01E-08
ENSG00000171045	TSNARE1	0.430	2.00E-03
ENSG00000176678	FOXL1	0.430	2.75E-05
ENSG00000175643	RMI2	0.430	2.06E-06
ENSG00000006704	GTF2IRD1	0.429	9.86E-10
ENSG00000248092	NNT-AS1	0.429	5.65E-07
ENSG00000274026	FAM27E3	0.429	8.97E-04
ENSG00000196159	FAT4	0.429	4.33E-06
ENSG00000133619	KRBA1	0.429	1.53E-05
ENSG00000263956	NBPF11	0.429	5.91E-05
ENSG00000148516	ZEB1	0.429	5.33E-06
ENSG00000153071	DAB2	0.429	4.56E-05
ENSG00000167395	ZNF646	0.428	5.76E-10
ENSG00000081026	MAGI3	0.428	2.12E-08
ENSG00000173209	AHSA2	0.427	1.27E-06
ENSG00000168300	PCMTD1	0.427	1.34E-06

ENSG00000139263	LRIG3	0.427	1.28E-07
ENSG00000158691	ZSCAN12	0.426	4.26E-06
ENSG00000159200	RCAN1	0.426	4.88E-08
ENSG00000144395	CCDC150	0.426	5.98E-04
ENSG00000050327	ARHGEF5	0.426	3.32E-08
ENSG00000077150	NFKB2	0.426	3.76E-10
ENSG00000127914	AKAP9	0.426	8.30E-10
ENSG00000204344	STK19	0.426	5.46E-06
ENSG00000180263	FGD6	0.426	2.22E-10
ENSG00000117266	CDK18	0.426	3.44E-05
ENSG00000198908	BHLHB9	0.425	1.75E-03
ENSG00000146021	KLHL3	0.425	1.59E-03
ENSG00000185019	UBOX5	0.425	1.59E-04
ENSG00000120071	KANSL1	0.425	2.21E-09
ENSG00000173011	TADA2B	0.425	5.85E-08
ENSG00000198315	ZKSCAN8	0.424	7.33E-10
ENSG00000140382	HMG20A	0.424	1.74E-08
ENSG00000065970	FOXJ2	0.424	3.42E-10
ENSG00000158813	EDA	0.424	2.56E-02
ENSG00000167257	RNF214	0.424	1.29E-06
ENSG00000196544	BORCS6	0.424	1.70E-03
ENSG00000236859	NIFK-AS1	0.423	6.19E-03
ENSG00000181450	ZNF678	0.423	1.62E-04
ENSG00000151773	CCDC122	0.423	1.88E-04
ENSG00000278970	HEIH	0.422	1.93E-06
ENSG00000177853	ZNF518A	0.422	5.12E-08
ENSG00000256087	ZNF432	0.422	6.47E-05
ENSG00000108389	MTMR4	0.422	3.70E-09
ENSG00000173918	C1QTNF1	0.422	1.04E-03
ENSG00000019995	ZRANB1	0.422	2.66E-10
ENSG00000124613	ZNF391	0.421	1.88E-05
ENSG00000178381	ZFAND2A	0.421	3.67E-05
ENSG00000121578	B4GALT4	0.421	2.43E-06
ENSG00000184860	SDR42E1	0.421	4.82E-07
ENSG00000167981	ZNF597	0.421	2.51E-04
ENSG00000173818	ENDOV	0.421	9.92E-04
ENSG00000226688	ENTPD1-AS1	0.421	2.10E-05
ENSG00000183775	KCTD16	0.421	5.07E-02
ENSG00000173040	EVC2	0.421	5.89E-05
ENSG00000114988	LMAN2L	0.421	4.90E-06
ENSG00000164743	C8orf48	0.421	6.77E-03
ENSG00000166037	CEP57	0.421	7.44E-09
ENSG00000160999	SH2B2	0.420	2.56E-02

ENSG00000130921	C12orf65	0.420	1.60E-06
ENSG00000175449	RFESD	0.420	1.61E-02
ENSG00000104312	RIPK2	0.420	1.17E-05
ENSG00000214021	TTLL3	0.419	4.51E-04
ENSG00000112234	FBXL4	0.419	6.25E-06
ENSG00000198646	NCOA6	0.419	1.33E-11
ENSG00000197063	MAFG	0.419	1.79E-08
ENSG00000234289	H2BFS	0.419	1.45E-02
ENSG00000138135	CH25H	0.419	1.94E-02
ENSG00000037637	FBXO42	0.419	4.97E-07
ENSG00000039139	DNAH5	0.418	9.71E-03
ENSG00000269821	KCNQ1OT1	0.418	2.19E-05
ENSG00000143614	GATAD2B	0.418	9.98E-10
ENSG00000170325	PRDM10	0.418	7.46E-07
ENSG00000175697	GPR156	0.418	1.08E-04
ENSG00000166349	RAG1	0.418	1.42E-02
ENSG00000066827	ZFAT	0.418	4.70E-05
ENSG00000141639	MAPK4	0.418	2.48E-02
ENSG00000175318	GRAMD2	0.417	2.01E-05
ENSG00000183655	KLHL25	0.417	7.43E-04
ENSG00000143494	VASH2	0.417	1.25E-02
ENSG00000213742	ZNF337-AS1	0.417	5.68E-03
ENSG00000167165	UGT1A6	0.417	2.81E-02
ENSG00000147251	DOCK11	0.416	3.19E-02
ENSG00000108840	HDAC5	0.416	2.01E-07
ENSG00000173517	PEAK1	0.416	1.45E-08
ENSG00000171943	SRGAP2C	0.416	3.55E-06
ENSG00000156787	TBC1D31	0.416	6.03E-07
ENSG00000236618	PITPNA-AS1	0.415	2.36E-04
ENSG00000141034	GID4	0.415	2.33E-06
ENSG00000128408	RIBC2	0.415	1.07E-04
ENSG00000136603	SKIL	0.415	7.23E-09
ENSG00000172167	MTBP	0.415	4.00E-07
ENSG00000115504	EHBP1	0.415	8.35E-12
ENSG00000107249	GLIS3	0.415	4.58E-03
ENSG00000119397	CNTRL	0.415	3.45E-08
ENSG00000116580	GON4L	0.415	8.17E-10
ENSG00000075539	FRYL	0.414	3.39E-10
ENSG00000138161	CUZD1	0.414	1.35E-02
ENSG00000120693	SMAD9	0.414	6.35E-04
ENSG00000112149	CD83	0.414	3.33E-06
ENSG00000168502	MTCL1	0.414	1.71E-07
ENSG00000245573	BDNF-AS	0.414	2.55E-02

ENSG00000171612	SLC25A33	0.414	2.73E-05
ENSG00000146263	MMS22L	0.414	1.15E-08
ENSG00000120709	FAM53C	0.413	1.23E-10
ENSG00000131941	RHPN2	0.413	1.42E-06
ENSG00000011258	MBTD1	0.413	2.86E-07
ENSG00000100815	TRIP11	0.413	3.78E-10
ENSG00000083223	ZCCHC6	0.413	1.85E-09
ENSG00000263513	FAM72C	0.412	1.62E-02
ENSG00000118412	CASP8AP2	0.412	4.00E-10
ENSG00000090339	ICAM1	0.412	1.82E-11
ENSG00000121417	ZNF211	0.412	4.14E-03
ENSG00000135679	MDM2	0.412	1.80E-09
ENSG00000245556	SCAMP1-AS1	0.411	1.62E-03
ENSG00000153029	MR1	0.411	2.10E-07
ENSG00000134744	ZCCHC11	0.411	1.47E-09
ENSG00000170919	TPT1-AS1	0.411	3.10E-04
ENSG00000080802	CNOT4	0.411	4.93E-10
ENSG00000164010	ERMAP	0.411	2.34E-04
ENSG00000163050	ADCK3	0.411	1.84E-04
ENSG00000173611	SCAI	0.411	9.33E-04
ENSG00000178177	LCORL	0.410	2.12E-04
ENSG00000121486	TRMT1L	0.410	2.42E-07
ENSG00000197978	GOLGA6L9	0.410	3.44E-03
ENSG00000163512	AZI2	0.410	1.27E-08
ENSG00000049769	PPP1R3F	0.409	9.78E-03
ENSG00000196611	MMP1	0.408	5.01E-05
ENSG00000145779	TNFAIP8	0.407	2.33E-08
ENSG00000154309	DISP1	0.407	3.01E-03
ENSG00000101751	POLI	0.407	5.91E-05
ENSG00000157426	AASDH	0.406	3.37E-05
ENSG00000204186	ZDBF2	0.406	5.78E-06
ENSG00000166348	USP54	0.406	1.19E-07
ENSG00000188994	ZNF292	0.406	3.41E-09
ENSG00000135363	LMO2	0.406	5.06E-02
ENSG00000198719	DLL1	0.405	5.82E-04
ENSG00000155287	SLC25A28	0.405	1.86E-08
ENSG00000158301	GPRASP2	0.404	4.93E-03
ENSG00000145990	GFOD1	0.404	4.06E-08
ENSG00000253797	UTP14C	0.403	1.48E-06
ENSG00000178752	FAM132B	0.403	1.94E-02
ENSG00000151090	THRB	0.403	5.09E-06
ENSG00000214944	ARHGEF28	0.403	6.49E-09
ENSG00000115170	ACVR1	0.402	4.35E-06

ENSG00000181638	ZFP41	0.402	4.68E-04
ENSG00000204084	INPP5B	0.402	7.50E-05
ENSG00000085433	WDR47	0.402	1.04E-06
ENSG00000066933	MYO9A	0.401	5.09E-10
ENSG00000122008	POLK	0.400	9.31E-07
ENSG00000157741	UBN2	0.400	1.95E-07
ENSG00000196782	MAML3	0.400	1.04E-03
ENSG00000181004	BBS12	0.400	2.49E-03
ENSG00000139899	CBLN3	0.399	3.05E-02
ENSG00000143379	SETDB1	0.399	3.53E-09
ENSG00000164758	MED30	0.399	9.79E-04
ENSG00000108799	EZH1	0.398	1.20E-06
ENSG00000109436	TBC1D9	0.398	1.11E-07
ENSG00000005339	CREBBP	0.398	2.14E-10
ENSG00000140987	ZSCAN32	0.397	3.18E-06
ENSG00000067798	NAV3	0.397	3.38E-03
ENSG00000162496	DHRS3	0.397	6.33E-06
ENSG00000150991	UBC	0.397	1.27E-09
ENSG00000100867	DHRS2	0.397	1.80E-03
ENSG00000072422	RHOBTB1	0.397	1.50E-04
ENSG00000180801	ARSJ	0.397	8.32E-08
ENSG00000062194	GPBP1	0.396	1.25E-09
ENSG00000109572	CLCN3	0.396	1.15E-09
ENSG00000177125	ZBTB34	0.396	8.28E-06
ENSG00000135373	EHF	0.396	1.70E-09
ENSG00000185261	KIAA0825	0.396	4.86E-02
ENSG00000249859	PVT1	0.395	5.23E-05
ENSG00000162599	NFIA	0.395	4.08E-10
ENSG00000214562	NUTM2D	0.395	3.28E-02
ENSG00000170954	ZNF415	0.395	5.97E-03
ENSG00000159256	MORC3	0.395	6.44E-08
ENSG00000125864	BFSP1	0.395	2.28E-03
ENSG00000161692	DBF4B	0.395	3.16E-07
ENSG00000175938	ORAI3	0.394	1.02E-02
ENSG00000081913	PHLPP1	0.394	1.05E-06
ENSG00000165548	TMEM63C	0.394	1.27E-03
ENSG00000171681	ATF7IP	0.394	2.86E-10
ENSG00000128833	MYO5C	0.393	6.73E-05
ENSG00000136826	KLF4	0.393	8.16E-09
ENSG00000215784	FAM72D	0.393	2.12E-02
ENSG00000095539	SEMA4G	0.393	6.25E-03
ENSG00000112837	TBX18	0.393	5.25E-06
ENSG00000149474	CSRP2BP	0.393	1.02E-07

ENSG00000152223	EPG5	0.393	1.91E-08
ENSG00000054282	SDCCAG8	0.393	1.24E-06
ENSG00000142197	DOPEY2	0.392	5.88E-04
ENSG00000171206	TRIM8	0.392	6.31E-09
ENSG00000198924	DCLRE1A	0.392	7.08E-07
ENSG00000107537	PHYH	0.392	4.49E-05
ENSG00000172766	NAA16	0.392	8.65E-07
ENSG00000168916	ZNF608	0.391	1.59E-06
ENSG00000140265	ZSCAN29	0.391	2.14E-07
ENSG00000205189	ZBTB10	0.391	1.27E-06
ENSG00000127328	RAB3IP	0.391	5.60E-07
ENSG00000221994	ZNF630	0.390	2.86E-02
ENSG00000114841	DNAH1	0.390	7.10E-03
ENSG00000163848	ZNF148	0.390	1.28E-09
ENSG00000140279	DUOX2	0.389	4.06E-02
ENSG00000167595	PROSER3	0.389	2.33E-07
ENSG00000101544	ADNP2	0.389	1.60E-09
ENSG00000205765	C5orf51	0.389	4.51E-09
ENSG00000033030	ZCCHC8	0.389	2.94E-09
ENSG00000143373	ZNF687	0.389	1.45E-07
ENSG00000243156	MICAL3	0.389	3.89E-09
ENSG00000132623	ANKEF1	0.388	3.38E-08
ENSG00000159921	GNE	0.388	4.37E-07
ENSG00000008311	AASS	0.388	1.12E-04
ENSG00000134242	PTPN22	0.388	3.00E-02
ENSG00000163694	RBM47	0.388	1.13E-07
ENSG00000167555	ZNF528	0.388	6.17E-04
ENSG00000261556	SMG1P7	0.388	1.59E-02
ENSG00000121236	TRIM6	0.387	1.37E-02
ENSG00000162139	NEU3	0.387	5.00E-07
ENSG00000197302	ZNF720	0.387	2.43E-04
ENSG00000187764	SEMA4D	0.387	5.20E-03
ENSG00000080546	SESN1	0.387	3.59E-05
ENSG00000105516	DBP	0.387	1.12E-02
ENSG00000122779	TRIM24	0.387	1.32E-08
ENSG00000065361	ERBB3	0.387	3.23E-04
ENSG00000162222	TTC9C	0.387	8.51E-05
ENSG00000181038	METTL23	0.387	1.32E-03
ENSG00000121211	MND1	0.387	5.32E-05
ENSG00000197959	DNM3	0.386	1.09E-02
ENSG00000122870	BICC1	0.386	2.74E-08
ENSG00000127993	RBM48	0.386	3.95E-05
ENSG00000183111	ARHGEF37	0.386	1.06E-04

ENSG00000173230	GOLGB1	0.386	2.41E-10
ENSG00000074621	SLC24A1	0.386	3.55E-05
ENSG00000151748	SAV1	0.386	3.73E-08
ENSG00000130758	MAP3K10	0.386	9.46E-05
ENSG00000102710	SUPT20H	0.385	1.64E-08
ENSG00000100147	CCDC134	0.385	1.65E-02
ENSG00000137947	GTF2B	0.384	3.57E-08
ENSG00000181444	ZNF467	0.384	3.45E-02
ENSG00000198105	ZNF248	0.384	2.42E-04
ENSG00000116675	DNAJC6	0.384	7.52E-03
ENSG00000184939	ZFP90	0.384	1.50E-07
ENSG00000168026	TTC21A	0.384	5.07E-02
ENSG00000166225	FRS2	0.383	4.48E-07
ENSG00000115423	DNAH6	0.383	4.76E-02
ENSG00000152193	RNF219	0.383	4.45E-08
ENSG00000023287	RB1CC1	0.383	1.41E-08
ENSG00000114127	XRN1	0.383	2.50E-07
ENSG00000171124	FUT3	0.382	2.63E-02
ENSG00000148841	ITPRIP	0.382	9.12E-10
ENSG00000143669	LYST	0.382	9.20E-06
ENSG00000091592	NLRP1	0.381	2.65E-08
ENSG00000109920	FNBP4	0.381	3.03E-10
ENSG00000082898	XPO1	0.380	6.15E-11
ENSG00000253313	C1orf210	0.379	8.94E-03
ENSG00000188878	FBF1	0.379	2.88E-02
ENSG00000100592	DAAM1	0.379	3.05E-07
ENSG00000143442	POGZ	0.379	7.63E-10
ENSG00000261824	LINC00662	0.379	5.35E-04
ENSG00000186480	INSIG1	0.378	6.85E-09
ENSG00000196605	ZNF846	0.378	4.23E-02
ENSG00000158615	PPP1R15B	0.378	6.79E-11
ENSG00000100578	KIAA0586	0.378	4.74E-07
ENSG00000163625	WDFY3	0.377	2.56E-09
ENSG00000137393	RNF144B	0.377	1.50E-06
ENSG00000175104	TRAF6	0.377	2.49E-06
ENSG00000196220	SRGAP3	0.376	7.75E-08
ENSG00000082458	DLG3	0.376	7.46E-07
ENSG00000159459	UBR1	0.376	7.38E-08
ENSG00000163872	YEATS2	0.376	8.43E-10
ENSG00000116731	PRDM2	0.376	9.36E-10
ENSG00000136152	COG3	0.376	3.30E-08
ENSG00000140836	ZFHX3	0.376	5.38E-07
ENSG00000140044	JDP2	0.376	9.92E-06

ENSG00000120334	CENPL	0.375	1.12E-07
ENSG00000106100	NOD1	0.375	2.54E-04
ENSG00000106948	AKNA	0.375	5.10E-04
ENSG00000203705	TATDN3	0.375	1.01E-04
ENSG00000177873	ZNF619	0.375	1.59E-03
ENSG00000248049	UBA6-AS1	0.375	8.37E-06
ENSG00000120833	SOCS2	0.375	2.91E-04
ENSG00000164190	NIPBL	0.375	8.54E-12
ENSG00000213988	ZNF90	0.375	2.09E-02
ENSG00000244694	PTCHD4	0.374	1.20E-02
ENSG00000138696	BMPR1B	0.374	4.27E-04
ENSG00000135709	KIAA0513	0.374	3.89E-05
ENSG00000186814	ZSCAN30	0.374	2.89E-06
ENSG00000106686	SPATA6L	0.374	3.95E-02
ENSG00000197275	RAD54B	0.373	3.50E-03
ENSG00000139112	GABARAPL1	0.373	2.66E-07
ENSG00000080200	CRYBG3	0.373	1.20E-06
ENSG00000132016	C19orf57	0.373	1.44E-04
ENSG00000154781	CCDC174	0.373	8.78E-07
ENSG00000163093	BBS5	0.373	1.46E-02
ENSG00000180346	TIGD2	0.373	2.60E-04
ENSG00000197927	C2orf27A	0.372	2.60E-02
ENSG00000168813	ZNF507	0.372	3.96E-06
ENSG00000238105	GOLGA2P5	0.372	1.54E-03
ENSG00000179698	WDR97	0.372	2.77E-02
ENSG00000135334	AKIRIN2	0.371	3.72E-08
ENSG00000101004	NINL	0.371	3.25E-06
ENSG00000230006	ANKRD36BP2	0.371	1.12E-02
ENSG00000106780	MEGF9	0.371	4.19E-07
ENSG00000142235	LMTK3	0.371	2.38E-03
ENSG00000123352	SPATS2	0.370	4.37E-09
ENSG00000167562	ZNF701	0.370	4.69E-04
ENSG00000116809	ZBTB17	0.370	1.01E-06
ENSG00000112983	BRD8	0.370	4.97E-10
ENSG00000128394	APOBEC3F	0.369	3.89E-02
ENSG00000188295	ZNF669	0.369	3.26E-03
ENSG00000228409	CCT6P1	0.368	1.59E-02
ENSG00000173295	FAM86B3P	0.368	1.52E-02
ENSG00000142599	RERE	0.368	1.15E-09
ENSG00000143033	MTF2	0.368	1.41E-07
ENSG00000170385	SLC30A1	0.368	1.78E-08
ENSG00000173614	NMNAT1	0.367	1.78E-05
ENSG00000196418	ZNF124	0.367	4.84E-03

ENSG00000186472	PCLO	0.367	4.53E-07
ENSG00000025039	RRAGD	0.367	5.00E-04
ENSG00000169435	RASSF6	0.367	6.56E-05
ENSG00000170271	FAXDC2	0.366	3.41E-02
ENSG00000122778	KIAA1549	0.366	2.66E-04
ENSG00000118156	ZNF541	0.366	2.31E-04
ENSG00000164066	INTU	0.366	5.04E-05
ENSG00000153317	ASAP1	0.366	1.30E-10
ENSG00000148842	CNNM2	0.366	5.09E-04
ENSG00000177932	ZNF354C	0.366	2.55E-05
ENSG00000156876	SASS6	0.365	4.82E-06
ENSG00000143498	TAF1A	0.365	1.08E-04
ENSG00000139990	DCAF5	0.365	3.58E-10
ENSG00000131051	RBM39	0.365	3.69E-11
ENSG00000158402	CDC25C	0.365	1.06E-06
ENSG00000137478	FCHSD2	0.365	1.05E-06
ENSG00000197892	KIF13B	0.364	6.43E-06
ENSG00000164327	RICTOR	0.364	3.43E-08
ENSG00000139636	LMBR1L	0.363	7.55E-04
ENSG00000179912	R3HDM2	0.362	3.39E-07
ENSG00000149016	TUT1	0.362	3.27E-04
ENSG00000051341	POLQ	0.362	5.34E-07
ENSG00000048707	VPS13D	0.362	3.10E-09
ENSG00000138078	PREPL	0.361	2.86E-09
ENSG00000185246	PRPF39	0.361	3.81E-06
ENSG00000225377	NRSN2-AS1	0.361	2.29E-02
ENSG00000168297	PXK	0.361	3.37E-05
ENSG00000049618	ARID1B	0.361	3.23E-09
ENSG00000197818	SLC9A8	0.360	1.83E-08
ENSG00000116852	KIF21B	0.360	1.51E-04
ENSG00000100591	AHSA1	0.360	5.11E-10
ENSG00000256771	ZNF253	0.360	5.74E-03
ENSG00000251474	RPL32P3	0.360	2.30E-03
ENSG00000137770	CTDSPL2	0.360	1.85E-07
ENSG00000151657	KIN	0.360	1.52E-05
ENSG00000156675	RAB11FIP1	0.360	1.38E-07
ENSG00000136098	NEK3	0.360	4.12E-05
ENSG00000033800	PIAS1	0.359	1.02E-08
ENSG00000133808	MICALCL	0.359	9.63E-06
ENSG00000147027	TMEM47	0.359	6.24E-03
ENSG00000162971	TYW5	0.358	6.12E-05
ENSG00000140948	ZCCHC14	0.358	4.20E-07
ENSG00000183309	ZNF623	0.358	5.97E-07

ENSG00000196588	MKL1	0.358	3.98E-08
ENSG00000127663	KDM4B	0.358	1.18E-05
ENSG00000168005	C11orf84	0.358	1.85E-06
ENSG00000224914	LINC00863	0.358	1.35E-04
ENSG00000100150	DEPDC5	0.357	1.53E-04
ENSG00000204305	AGER	0.357	1.10E-02
ENSG00000164002	EXO5	0.357	1.61E-04
ENSG00000108515	ENO3	0.357	3.54E-03
ENSG00000111271	ACAD10	0.357	9.01E-05
ENSG00000171604	CXXC5	0.357	2.26E-02
ENSG00000157833	GAREML	0.357	4.24E-02
ENSG00000100784	RPS6KA5	0.355	2.91E-04
ENSG00000114739	ACVR2B	0.355	1.01E-03
ENSG00000169914	OTUD3	0.355	3.68E-05
ENSG00000139117	CPNE8	0.355	8.01E-04
ENSG00000156521	TYSND1	0.355	7.21E-06
ENSG00000176208	ATAD5	0.355	6.25E-06
ENSG00000173889	PHC3	0.354	7.59E-09
ENSG00000122482	ZNF644	0.354	1.76E-08
ENSG00000138623	SEMA7A	0.353	1.47E-06
ENSG00000144749	LRIG1	0.353	1.61E-04
ENSG00000178966	RMI1	0.353	1.38E-06
ENSG00000065809	FAM107B	0.353	9.32E-07
ENSG00000197283	SYNGAP1	0.352	4.24E-07
ENSG00000179335	CLK3	0.352	6.38E-08
ENSG00000112282	MED23	0.352	2.11E-07
ENSG00000152443	ZNF776	0.352	2.00E-04
ENSG00000085274	MYNN	0.352	8.61E-06
ENSG00000077157	PPP1R12B	0.352	7.15E-06
ENSG00000166845	C18orf54	0.352	4.02E-06
ENSG00000138346	DNA2	0.352	8.97E-06
ENSG00000131115	ZNF227	0.351	4.10E-04
ENSG00000011332	DPF1	0.351	2.84E-02
ENSG00000268895	A1BG-AS1	0.351	1.85E-02
ENSG00000143751	SDE2	0.351	1.74E-07
ENSG00000166192	SENP8	0.351	7.26E-03
ENSG00000052344	PRSS8	0.351	4.40E-06
ENSG00000137449	CPEB2	0.351	1.24E-05
ENSG00000116044	NFE2L2	0.351	2.01E-10
ENSG00000167380	ZNF226	0.351	1.13E-03
ENSG00000185760	KCNQ5	0.351	1.13E-05
ENSG00000071205	ARHGAP10	0.351	1.58E-06
ENSG00000204498	NFKBIL1	0.350	1.24E-05

ENSG00000165355	FBXO33	0.350	1.67E-05
ENSG00000168876	ANKRD49	0.350	4.98E-04
ENSG00000150455	TIRAP	0.349	3.93E-03
ENSG00000135837	CEP350	0.349	9.49E-10
ENSG00000197261	C6orf141	0.349	7.53E-04
ENSG00000170085	SIMC1	0.349	4.27E-07
ENSG00000132376	INPP5K	0.349	3.50E-05
ENSG00000170264	FAM161A	0.349	1.36E-04
ENSG00000154957	ZNF18	0.349	1.17E-02
ENSG00000121989	ACVR2A	0.349	1.98E-04
ENSG00000198455	ZXDB	0.349	1.77E-06
ENSG00000164970	FAM219A	0.349	1.02E-05
ENSG00000170006	TMEM154	0.348	8.14E-08
ENSG00000109103	UNC119	0.348	1.62E-05
ENSG00000157036	EXOG	0.348	2.34E-04
ENSG00000198355	PIM3	0.348	4.94E-07
ENSG00000012817	KDM5D	0.348	5.86E-06
ENSG00000089177	KIF16B	0.347	2.03E-07
ENSG00000116205	TCEANC2	0.347	7.67E-06
ENSG00000079432	CIC	0.347	7.66E-08
ENSG00000185621	LMLN	0.347	2.54E-05
ENSG00000117479	SLC19A2	0.347	2.94E-05
ENSG00000101574	METTL4	0.346	8.10E-05
ENSG00000143842	SOX13	0.346	2.24E-06
ENSG00000133812	SBF2	0.346	1.42E-07
ENSG00000196792	STRN3	0.346	1.04E-07
ENSG00000146587	RBAK	0.346	7.07E-07
ENSG00000223573	TINCR	0.346	1.99E-02
ENSG00000099308	MAST3	0.345	3.27E-04
ENSG00000130545	CRB3	0.345	1.37E-02
ENSG00000146530	VWDE	0.345	2.48E-02
ENSG00000121749	TBC1D15	0.345	3.85E-07
ENSG00000141068	KSR1	0.345	5.42E-03
ENSG00000094975	SUCO	0.345	1.06E-06
ENSG00000092098	RNF31	0.345	4.84E-05
ENSG00000010318	PHF7	0.345	6.92E-03
ENSG00000108733	PEX12	0.345	8.71E-04
ENSG00000138032	PPM1B	0.344	4.60E-06
ENSG00000185917	SETD4	0.344	1.66E-04
ENSG00000146083	RNF44	0.344	2.05E-07
ENSG00000196584	XRCC2	0.344	9.15E-07
ENSG00000164609	SLU7	0.344	9.13E-09
ENSG00000163171	CDC42EP3	0.343	5.31E-09

ENSG00000135111	TBX3	0.343	5.41E-04
ENSG00000004139	SARM1	0.343	7.68E-03
ENSG00000176473	WDR25	0.343	2.87E-03
ENSG00000186073	C15orf41	0.343	4.47E-05
ENSG00000114120	SLC25A36	0.343	1.05E-07
ENSG00000267278	MAP3K14-AS1	0.343	4.23E-02
ENSG00000204644	ZFP57	0.343	1.31E-07
ENSG00000145911	N4BP3	0.342	2.03E-05
ENSG00000149548	CCDC15	0.342	2.29E-04
ENSG00000198001	IRAK4	0.341	2.27E-04
ENSG00000171428	NAT1	0.341	6.00E-03
ENSG00000186162	CIDECP	0.341	1.26E-03
ENSG00000008517	IL32	0.341	9.09E-04
ENSG00000121413	ZSCAN18	0.340	3.00E-02
ENSG00000198799	LRIG2	0.340	3.03E-06
ENSG00000175906	ARL4D	0.340	3.37E-07
ENSG00000186104	CYP2R1	0.340	1.18E-04
ENSG00000135870	RC3H1	0.340	8.36E-06
ENSG00000170485	NPAS2	0.339	3.81E-06
ENSG00000148814	LRRC27	0.339	2.39E-02
ENSG00000101333	PLCB4	0.339	1.83E-02
ENSG00000236753	MKLN1-AS	0.339	3.21E-02
ENSG00000106829	TLE4	0.339	1.77E-04
ENSG00000151136	BTBD11	0.339	3.96E-04
ENSG00000135473	PAN2	0.339	6.29E-07
ENSG00000165983	PTER	0.338	2.05E-05
ENSG00000145375	SPATA5	0.338	6.62E-05
ENSG00000138433	CIR1	0.338	8.44E-07
ENSG00000148429	USP6NL	0.338	9.13E-07
ENSG00000164187	LMBRD2	0.338	1.17E-05
ENSG00000162194	LBHD1	0.338	3.82E-02
ENSG00000189308	LIN54	0.338	8.56E-07
ENSG00000240875	LINC00886	0.338	1.49E-02
ENSG00000012048	BRCA1	0.338	2.29E-09
ENSG00000165891	E2F7	0.337	6.00E-07
ENSG00000070159	PTPN3	0.337	5.00E-09
ENSG00000268043	NBPF12	0.337	1.04E-03
ENSG00000109674	NEIL3	0.337	2.17E-05
ENSG00000079387	SENP1	0.337	5.26E-09
ENSG00000170921	TANC2	0.337	1.01E-09
ENSG00000204920	ZNF155	0.337	1.81E-02
ENSG00000164169	PRMT9	0.337	6.58E-04
ENSG00000118873	RAB3GAP2	0.337	1.14E-08

ENSG00000108379	WNT3	0.336	2.01E-02
ENSG00000100968	NFATC4	0.336	5.60E-03
ENSG00000178075	GRAMD1C	0.336	6.95E-03
ENSG00000139946	PELI2	0.336	1.83E-02
ENSG00000197619	ZNF615	0.336	8.83E-03
ENSG00000136122	BORA	0.336	2.11E-05
ENSG00000155096	AZIN1	0.335	5.07E-09
ENSG00000073331	ALPK1	0.335	1.16E-04
ENSG00000165288	BRWD3	0.335	2.31E-07
ENSG00000135362	PRR5L	0.335	4.22E-03
ENSG00000148153	INIP	0.335	2.55E-06
ENSG00000140543	DET1	0.335	3.45E-02
ENSG00000170145	SIK2	0.335	1.43E-07
ENSG00000167081	PBX3	0.335	2.60E-06
ENSG00000154237	LRRK1	0.334	7.69E-07
ENSG00000172007	RAB33B	0.334	5.34E-05
ENSG00000167363	FN3K	0.334	5.03E-02
ENSG00000110318	CEP126	0.334	1.02E-04
ENSG00000243364	EFNA4	0.334	5.15E-03
ENSG00000164252	AGGF1	0.334	1.29E-07
ENSG00000204959	ARHGEF34P	0.333	2.42E-04
ENSG00000116539	ASH1L	0.333	1.88E-09
ENSG00000234545	FAM133B	0.333	1.78E-05
ENSG00000134369	NAV1	0.333	9.00E-08
ENSG00000162928	PEX13	0.332	2.46E-07
ENSG00000109452	INPP4B	0.332	1.61E-07
ENSG00000196470	SIAH1	0.332	1.07E-04
ENSG00000130363	RSPH3	0.331	1.52E-05
ENSG00000133739	LRRCC1	0.331	1.38E-04
ENSG00000148572	NRBF2	0.331	1.05E-05
ENSG00000133065	SLC41A1	0.331	1.69E-08
ENSG00000106701	FSD1L	0.331	1.46E-03
ENSG00000206149	HERC2P9	0.330	4.05E-03
ENSG00000140563	MCTP2	0.330	8.81E-05
ENSG00000016391	CHDH	0.330	6.77E-03
ENSG00000135451	TROAP	0.330	9.58E-07
ENSG00000150995	ITPR1	0.330	1.09E-04
ENSG00000182400	TRAPPC6B	0.330	7.25E-07
ENSG00000011198	ABHD5	0.330	1.68E-05
ENSG00000108061	SHOC2	0.329	1.00E-06
ENSG00000011132	APBA3	0.329	7.38E-04
ENSG00000144597	EAF1	0.328	6.42E-08
ENSG00000198155	ZNF876P	0.328	3.39E-02

ENSG00000077935	SMC1B	0.328	5.01E-04
ENSG00000198815	FOXJ3	0.328	4.79E-09
ENSG00000105053	VRK3	0.328	9.23E-05
ENSG00000215424	MCM3AP-AS1	0.328	1.15E-02
ENSG00000198853	RUSC2	0.328	4.26E-07
ENSG00000136715	SAP130	0.328	2.91E-07
ENSG00000125386	FAM193A	0.328	1.35E-07
ENSG00000168152	THAP9	0.328	7.72E-03
ENSG00000151470	C4orf33	0.328	1.19E-03
ENSG00000139625	MAP3K12	0.327	6.46E-04
ENSG00000140471	LINS1	0.327	6.03E-04
ENSG00000174206	C12orf66	0.327	1.72E-03
ENSG00000143398	PIP5K1A	0.327	7.11E-09
ENSG00000241015	TPM3P9	0.327	1.09E-02
ENSG00000196730	DAPK1	0.327	5.00E-02
ENSG00000131023	LATS1	0.327	3.05E-08
ENSG00000115758	ODC1	0.326	1.61E-10
ENSG00000101040	ZMYND8	0.326	1.84E-10
ENSG00000143776	CDC42BPA	0.326	3.13E-08
ENSG00000181788	SIAH2	0.326	3.38E-08
ENSG00000175455	CCDC14	0.326	5.55E-07
ENSG00000102221	JADE3	0.326	1.09E-04
ENSG00000117036	ETV3	0.326	7.27E-08
ENSG00000119431	HDHD3	0.325	5.38E-03
ENSG00000149256	TENM4	0.325	1.69E-02
ENSG00000165118	C9orf64	0.324	2.94E-06
ENSG00000065491	TBC1D22B	0.324	1.98E-06
ENSG00000101966	XIAP	0.324	1.61E-07
ENSG00000100393	EP300	0.324	2.44E-08
ENSG00000147124	ZNF41	0.324	7.10E-06
ENSG00000146247	PHIP	0.323	6.77E-08
ENSG00000139746	RBM26	0.323	4.53E-08
ENSG00000083844	ZNF264	0.323	3.67E-05
ENSG00000165626	BEND7	0.323	3.39E-02
ENSG00000140262	TCF12	0.323	4.46E-08
ENSG00000221817	PPP3CB-AS1	0.323	1.11E-02
ENSG00000111554	MDM1	0.322	4.02E-04
ENSG00000166169	POLL	0.322	4.76E-04
ENSG00000125967	NECAB3	0.322	4.70E-03
ENSG00000130150	MOSPD2	0.322	9.78E-05
ENSG00000170775	GPR37	0.321	4.49E-02
ENSG00000163697	APBB2	0.321	1.40E-07
ENSG00000131018	SYNE1	0.321	2.95E-04

ENSG00000160172	FAM86C2P	0.320	1.40E-02
ENSG00000026950	BTN3A1	0.320	2.59E-03
ENSG00000122483	CCDC18	0.320	1.54E-05
ENSG00000107362	ABHD17B	0.320	2.48E-03
ENSG00000024048	UBR2	0.320	6.72E-07
ENSG00000180376	CCDC66	0.320	5.19E-05
ENSG00000140199	SLC12A6	0.320	1.88E-05
ENSG00000073614	KDM5A	0.320	4.67E-09
ENSG00000092621	PHGDH	0.320	2.32E-07
ENSG00000166444	ST5	0.320	7.00E-07
ENSG00000149054	ZNF215	0.319	2.55E-03
ENSG00000178913	TAF7	0.319	1.11E-07
ENSG00000115459	ELMOD3	0.319	1.19E-04
ENSG00000091844	RGS17	0.319	3.04E-02
ENSG00000140104	C14orf79	0.318	2.86E-03
ENSG00000083896	YTHDC1	0.318	2.60E-09
ENSG00000128283	CDC42EP1	0.318	1.89E-07
ENSG00000123552	USP45	0.318	3.19E-04
ENSG00000114378	HYAL1	0.318	4.94E-02
ENSG00000197557	TTC30A	0.317	3.31E-02
ENSG00000068137	PLEKHH3	0.317	3.78E-05
ENSG00000141012	GALNS	0.316	1.81E-04
ENSG00000005810	MYCBP2	0.316	1.36E-08
ENSG00000166704	ZNF606	0.316	3.29E-02
ENSG00000171161	ZNF672	0.316	8.88E-05
ENSG00000174951	FUT1	0.316	3.31E-03
ENSG00000076604	TRAF4	0.316	3.16E-07
ENSG00000197555	SIPA1L1	0.315	1.68E-09
ENSG00000173273	TNKS	0.315	6.60E-08
ENSG00000169925	BRD3	0.315	4.12E-07
ENSG00000184481	FOXO4	0.315	2.14E-02
ENSG00000095574	IKZF5	0.315	1.67E-05
ENSG00000156869	FRRS1	0.315	1.22E-02
ENSG00000114861	FOXP1	0.315	5.48E-07
ENSG00000198399	ITSN2	0.314	5.52E-07
ENSG00000100599	RIN3	0.314	4.46E-04
ENSG00000116514	RNF19B	0.314	1.11E-06
ENSG00000239305	RNF103	0.314	1.83E-05
ENSG00000075391	RASAL2	0.314	5.16E-07
ENSG00000107957	SH3PXD2A	0.314	7.83E-08
ENSG00000204991	SPIRE2	0.313	4.64E-02
ENSG00000185483	ROR1	0.313	6.51E-03
ENSG00000182903	ZNF721	0.313	1.25E-05

ENSG00000186566	GPATCH8	0.313	2.61E-09
ENSG00000130962	PRRG1	0.312	1.82E-03
ENSG00000078804	TP53INP2	0.312	2.63E-06
ENSG00000157107	FCHO2	0.312	2.36E-05
ENSG00000121988	ZRANB3	0.312	2.01E-04
ENSG00000278709	NKILA	0.312	2.42E-03
ENSG00000124313	IQSEC2	0.312	1.06E-03
ENSG00000196458	ZNF605	0.312	4.71E-04
ENSG00000086289	EPDR1	0.312	2.60E-03
ENSG00000137601	NEK1	0.312	7.49E-06
ENSG00000186130	ZBTB6	0.312	7.75E-06
ENSG00000089234	BRAP	0.311	4.12E-07
ENSG00000197568	HHLA3	0.311	9.16E-04
ENSG00000160360	GPSM1	0.311	6.99E-04
ENSG00000165275	TRMT10B	0.311	2.15E-03
ENSG00000188227	ZNF793	0.311	2.03E-02
ENSG00000181467	RAP2B	0.311	5.98E-08
ENSG00000083750	RRAGB	0.311	9.41E-03
ENSG00000158715	SLC45A3	0.311	2.52E-02
ENSG00000143190	POU2F1	0.311	1.39E-06
ENSG00000156313	RPGR	0.311	3.62E-03
ENSG00000167513	CDT1	0.310	5.40E-05
ENSG00000104218	CSPP1	0.310	8.72E-05
ENSG00000116151	MORN1	0.310	9.52E-03
ENSG00000148154	UGCG	0.310	3.76E-05
ENSG00000172728	FUT10	0.310	1.14E-02
ENSG00000152939	MARVELD2	0.309	1.16E-06
ENSG00000119711	ALDH6A1	0.309	2.28E-03
ENSG00000119771	KLHL29	0.309	1.15E-03
ENSG00000196912	ANKRD36B	0.309	2.03E-02
ENSG00000100889	PCK2	0.309	1.45E-05
ENSG00000126775	ATG14	0.309	2.42E-05
ENSG00000132854	KANK4	0.308	4.29E-03
ENSG00000137968	SLC44A5	0.308	3.22E-02
ENSG00000129422	MTUS1	0.308	3.41E-07
ENSG00000143514	TP53BP2	0.308	5.04E-07
ENSG00000196263	ZNF471	0.308	5.01E-02
ENSG00000165322	ARHGAP12	0.307	6.05E-06
ENSG00000168228	ZCCHC4	0.307	4.41E-04
ENSG00000133805	AMPD3	0.307	6.18E-04
ENSG00000107771	CCSER2	0.307	3.62E-06
ENSG00000111249	CUX2	0.306	5.10E-06
ENSG00000112715	VEGFA	0.306	2.04E-09

ENSG00000108510	MED13	0.306	2.99E-08
ENSG00000127995	CASD1	0.306	1.12E-02
ENSG00000154920	EME1	0.306	2.96E-04
ENSG00000116885	OSCP1	0.305	1.82E-02
ENSG00000181481	RNF135	0.305	1.67E-03
ENSG00000204611	ZNF616	0.305	1.86E-03
ENSG00000039319	ZFYVE16	0.305	1.58E-06
ENSG00000052802	MSMO1	0.305	2.64E-07
ENSG00000137135	ARHGEF39	0.305	9.65E-04
ENSG00000100281	HMGXB4	0.305	2.74E-07
ENSG00000187626	ZKSCAN4	0.305	1.32E-02
ENSG00000108175	ZMIZ1	0.305	5.12E-07
ENSG00000146833	TRIM4	0.304	2.35E-06
ENSG00000197442	MAP3K5	0.304	2.10E-04
ENSG00000128563	PRKRIP1	0.304	4.44E-06
ENSG00000138738	PRDM5	0.303	1.15E-03
ENSG00000164438	TLX3	0.303	3.66E-02
ENSG00000170629	DPY19L2P2	0.303	2.18E-02
ENSG00000011275	RNF216	0.303	8.66E-07
ENSG00000135148	TRAFD1	0.303	1.85E-06
ENSG00000157184	CPT2	0.303	8.02E-06
ENSG00000151445	VIPAS39	0.303	7.03E-05
ENSG00000164830	OXR1	0.303	1.83E-06
ENSG00000198556	ZNF789	0.302	2.06E-03
ENSG00000162817	C1orf115	0.302	1.55E-02
ENSG00000137177	KIF13A	0.302	1.73E-07
ENSG00000070269	TMEM260	0.302	3.94E-04
ENSG00000276550	HERC2P2	0.302	1.98E-02
ENSG00000255769	GOLGA2P10	0.301	4.42E-03
ENSG00000236104	ZBTB22	0.301	2.07E-03
ENSG00000102081	FMR1	0.301	9.90E-06
ENSG00000133111	RFXAP	0.301	2.53E-02
ENSG00000120690	ELF1	0.301	5.34E-08
ENSG00000183718	TRIM52	0.301	1.75E-04
ENSG00000211455	STK38L	0.301	1.12E-07
ENSG00000073711	PPP2R3A	0.300	1.22E-04
ENSG00000100077	ADRBK2	0.300	1.05E-04
ENSG00000155158	TTC39B	0.300	6.36E-04
ENSG00000100228	RAB36	0.300	1.92E-02
ENSG00000133710	SPINK5	0.300	2.04E-02
ENSG00000182141	ZNF708	0.300	1.22E-02
ENSG00000250462	LRRC37BP1	0.299	3.41E-03
ENSG00000129518	EAPP	0.299	2.98E-06

ENSG00000247572	CKMT2-AS1	0.299	2.90E-03
ENSG00000124181	PLCG1	0.299	4.27E-09
ENSG00000197937	ZNF347	0.299	3.20E-03
ENSG00000205885	C1RL-AS1	0.299	3.12E-05
ENSG00000170537	TMC7	0.298	4.61E-03
ENSG00000148225	WDR31	0.298	1.69E-02
ENSG00000147874	HAUS6	0.298	7.66E-07
ENSG00000188015	S100A3	0.297	9.10E-04
ENSG00000122863	CHST3	0.297	4.93E-09
ENSG00000118482	PHF3	0.297	2.16E-08
ENSG00000074054	CLASP1	0.297	2.97E-09
ENSG00000131061	ZNF341	0.297	1.44E-02
ENSG00000110619	CARS	0.297	8.85E-08
ENSG00000116127	ALMS1	0.296	1.57E-07
ENSG00000119965	C10orf88	0.296	1.75E-03
ENSG00000181264	TMEM136	0.296	4.59E-02
ENSG00000132849	INADL	0.296	1.49E-06
ENSG00000164251	F2RL1	0.296	2.03E-06
ENSG00000142731	PLK4	0.296	6.46E-08
ENSG00000182993	C12orf60	0.296	4.28E-02
ENSG00000134070	IRAK2	0.296	8.02E-06
ENSG00000186318	BACE1	0.295	5.76E-05
ENSG00000197429	IPP	0.295	1.18E-03
ENSG00000129197	RPAIN	0.295	8.34E-04
ENSG00000141446	ESCO1	0.295	4.01E-06
ENSG00000116017	ARID3A	0.295	1.30E-03
ENSG00000100330	MTMR3	0.295	2.34E-07
ENSG00000108771	DHX58	0.295	6.39E-03
ENSG00000065675	PRKCQ	0.295	1.32E-02
ENSG00000136141	LRCH1	0.295	7.93E-06
ENSG00000266074	BAHCC1	0.294	7.37E-05
ENSG00000171160	MORN4	0.294	1.05E-02
ENSG00000071282	LMCD1	0.294	5.31E-03
ENSG00000248508	SRP14-AS1	0.294	4.10E-02
ENSG00000153933	DGKE	0.294	4.41E-04
ENSG00000173064	HECTD4	0.293	3.38E-06
ENSG00000237036	ZEB1-AS1	0.293	2.85E-02
ENSG00000122557	HERPUD2	0.293	2.51E-07
ENSG00000118507	AKAP7	0.293	3.17E-02
ENSG00000197321	SVIL	0.293	3.39E-08
ENSG00000094841	UPRT	0.293	2.35E-03
ENSG00000184083	FAM120C	0.292	7.73E-03
ENSG00000084676	NCOA1	0.292	2.05E-05

ENSG00000068024	HDAC4	0.292	1.85E-03
ENSG00000134253	TRIM45	0.292	2.00E-02
ENSG00000165632	TAF3	0.291	1.34E-05
ENSG00000167565	SERTAD3	0.291	3.77E-04
ENSG00000147162	OGT	0.291	1.08E-06
ENSG00000167034	NKX3-1	0.291	6.23E-04
ENSG00000171105	INSR	0.291	2.11E-03
ENSG00000112039	FANCE	0.291	1.12E-04
ENSG00000160058	BSDC1	0.290	7.35E-07
ENSG00000197603	C5orf42	0.290	5.34E-07
ENSG00000046651	OFD1	0.290	3.38E-05
ENSG00000254470	AP5B1	0.289	1.49E-05
ENSG00000169375	SIN3A	0.289	1.53E-08
ENSG00000119321	FKBP15	0.289	1.19E-07
ENSG00000114374	USP9Y	0.289	3.37E-06
ENSG00000101639	CEP192	0.289	9.01E-07
ENSG00000119801	YPEL5	0.289	5.46E-06
ENSG00000175322	ZNF519	0.289	7.83E-03
ENSG00000137269	LRRC1	0.289	6.30E-04
ENSG00000182831	C16orf72	0.289	1.59E-06
ENSG00000011454	RABGAP1	0.289	1.47E-06
ENSG00000117569	PTBP2	0.289	2.00E-03
ENSG00000157764	BRAF	0.288	7.57E-06
ENSG00000088387	DOCK9	0.288	9.90E-08
ENSG00000172888	ZNF621	0.288	3.52E-05
ENSG00000058729	RIOK2	0.288	8.95E-06
ENSG00000147862	NFIB	0.288	2.28E-08
ENSG00000181045	SLC26A11	0.288	1.45E-02
ENSG00000171843	MLLT3	0.288	3.84E-04
ENSG00000156463	SH3RF2	0.288	6.66E-08
ENSG00000149289	ZC3H12C	0.288	1.08E-06
ENSG00000170581	STAT2	0.288	2.97E-06
ENSG00000085511	MAP3K4	0.287	2.09E-06
ENSG00000172613	RAD9A	0.287	4.45E-04
ENSG00000214425	LRRC37A4P	0.287	9.92E-03
ENSG00000197885	NKIRAS1	0.287	5.11E-03
ENSG00000146243	IRAK1BP1	0.287	1.39E-02
ENSG00000005889	ZFX	0.287	6.43E-06
ENSG00000165424	ZCCHC24	0.287	4.73E-03
ENSG00000128578	STRIP2	0.287	1.25E-04
ENSG00000261609	GAN	0.287	2.70E-04
ENSG00000169359	SLC33A1	0.286	4.46E-06
ENSG00000185513	L3MBTL1	0.286	1.41E-02

ENSG00000168672	FAM84B	0.286	2.06E-06
ENSG00000144026	ZNF514	0.286	3.27E-03
ENSG00000171444	MCC	0.286	4.49E-08
ENSG00000134982	APC	0.286	1.23E-08
ENSG00000175595	ERCC4	0.286	1.48E-04
ENSG00000081377	CDC14B	0.286	2.33E-04
ENSG00000197056	ZMYM1	0.286	1.37E-03
ENSG00000151276	MAGI1	0.286	2.84E-04
ENSG00000117533	VAMP4	0.286	3.86E-04
ENSG00000131069	ACSS2	0.286	4.69E-07
ENSG00000129493	HEATR5A	0.285	1.11E-03
ENSG00000131263	RLIM	0.285	5.32E-08
ENSG00000198265	HELZ	0.285	4.63E-08
ENSG00000198198	SZT2	0.285	1.85E-06
ENSG00000112659	CUL9	0.285	5.51E-05
ENSG00000110274	CEP164	0.284	4.11E-07
ENSG00000113638	TTC33	0.284	2.57E-03
ENSG00000119778	ATAD2B	0.284	1.43E-04
ENSG00000113761	ZNF346	0.284	1.22E-04
ENSG00000184208	C22orf46	0.284	6.49E-06
ENSG00000160007	ARHGAP35	0.284	3.42E-07
ENSG00000221909	FAM200A	0.283	1.73E-03
ENSG00000120798	NR2C1	0.283	1.57E-04
ENSG00000137776	SLTM	0.283	5.78E-09
ENSG00000131944	FAAP24	0.283	5.34E-03
ENSG00000168826	ZBTB49	0.283	9.32E-03
ENSG00000167522	ANKRD11	0.283	1.14E-09
ENSG00000134644	PUM1	0.282	1.81E-08
ENSG00000130449	ZSWIM6	0.282	4.64E-07
ENSG00000107796	ACTA2	0.282	3.99E-02
ENSG00000140853	NLRC5	0.282	9.01E-03
ENSG00000161914	ZNF653	0.282	4.41E-02
ENSG00000129355	CDKN2D	0.282	1.19E-02
ENSG00000137221	TJAP1	0.282	3.08E-05
ENSG00000127191	TRAF2	0.282	5.26E-06
ENSG00000146373	RNF217	0.281	2.65E-05
ENSG00000132357	CARD6	0.281	1.77E-05
ENSG00000164715	LMTK2	0.281	6.76E-07
ENSG00000113319	RASGRF2	0.281	5.26E-04
ENSG00000051825	MPHOSPH9	0.281	3.64E-05
ENSG00000145819	ARHGAP26	0.281	7.03E-05
ENSG00000204386	NEU1	0.280	3.72E-05
ENSG00000128487	SPECC1	0.280	1.72E-07

ENSG00000120662	MTRF1	0.279	4.33E-03
ENSG00000112561	TFEB	0.279	1.12E-03
ENSG00000004777	ARHGAP33	0.279	7.21E-03
ENSG00000188559	RALGAPA2	0.279	1.79E-06
ENSG00000198920	KIAA0753	0.279	8.42E-05
ENSG00000163516	ANKZF1	0.279	3.81E-05
ENSG00000205356	TECPR1	0.279	9.89E-03
ENSG00000114737	CISH	0.279	3.15E-02
ENSG00000100124	ANKRD54	0.279	3.62E-04
ENSG00000214765	SEPT7P2	0.278	6.97E-03
ENSG00000132478	UNK	0.278	1.75E-04
ENSG00000204859	ZBTB48	0.278	1.80E-04
ENSG00000124459	ZNF45	0.278	1.18E-03
ENSG00000175073	VCPIP1	0.278	3.10E-05
ENSG00000094804	CDC6	0.278	2.46E-07
ENSG00000250251	PKD1P6	0.278	2.06E-03
ENSG00000115520	COQ10B	0.278	4.66E-04
ENSG00000072121	ZFYVE26	0.278	6.04E-06
ENSG00000116138	DNAJC16	0.278	8.24E-05
ENSG00000125898	FAM110A	0.277	3.26E-04
ENSG00000231074	HCG18	0.277	5.37E-05
ENSG00000160766	GBAP1	0.277	4.06E-02
ENSG00000182183	FAM159A	0.277	2.88E-02
ENSG00000107890	ANKRD26	0.277	3.30E-03
ENSG00000211459	MT-RNR1	0.277	1.83E-02
ENSG00000155640	C10orf12	0.277	4.88E-03
ENSG00000128000	ZNF780B	0.277	4.72E-02
ENSG00000126870	WDR60	0.276	1.08E-04
ENSG00000157625	TAB3	0.276	3.76E-08
ENSG00000174306	ZHX3	0.276	4.49E-07
ENSG00000104946	TBC1D17	0.276	3.26E-04
ENSG00000179562	GCC1	0.276	4.79E-05
ENSG00000141232	TOB1	0.276	1.57E-05
ENSG00000144560	VGLL4	0.276	1.21E-06
ENSG00000158158	CNNM4	0.276	2.78E-05
ENSG00000079156	OSBPL6	0.275	1.03E-04
ENSG00000011566	MAP4K3	0.275	1.27E-04
ENSG00000165799	RNASE7	0.275	2.07E-03
ENSG00000146414	SHPRH	0.275	6.92E-05
ENSG00000102781	KATNAL1	0.275	1.27E-05
ENSG00000166900	STX3	0.275	1.76E-04
ENSG00000136169	SETDB2	0.275	1.97E-03
ENSG00000121067	SPOP	0.274	2.41E-06

ENSG00000181472	ZBTB2	0.274	7.76E-06
ENSG00000172432	GTPBP2	0.274	3.61E-07
ENSG00000158201	ABHD3	0.274	2.98E-03
ENSG00000178498	DTX3	0.274	8.81E-04
ENSG00000165813	CCDC186	0.274	3.95E-05
ENSG00000077454	LRCH4	0.273	3.67E-03
ENSG00000188827	SLX4	0.273	1.08E-04
ENSG00000070366	SMG6	0.273	3.06E-06
ENSG00000182150	ERCC6L2	0.273	6.75E-05
ENSG00000165392	WRN	0.273	2.05E-05
ENSG00000135093	USP30	0.273	1.34E-03
ENSG00000120832	MTERF2	0.273	1.94E-02
ENSG00000127220	ABHD8	0.273	2.01E-02
ENSG00000198892	SHISA4	0.272	4.89E-02
ENSG00000188785	ZNF548	0.272	8.32E-03
ENSG00000006652	IFRD1	0.272	3.63E-07
ENSG00000062725	APPBP2	0.272	4.62E-05
ENSG00000215271	HOMEZ	0.272	2.16E-04
ENSG00000204130	RUFY2	0.271	8.86E-05
ENSG00000165512	ZNF22	0.271	1.55E-04
ENSG00000119906	SLF2	0.271	3.72E-06
ENSG00000173821	RNF213	0.271	3.73E-07
ENSG00000184677	ZBTB40	0.271	7.98E-06
ENSG00000109929	SC5D	0.270	5.85E-06
ENSG00000085840	ORC1	0.270	9.69E-06
ENSG00000248360	LINC00504	0.270	2.22E-02
ENSG00000183808	RBM12B	0.270	1.51E-05
ENSG00000187240	DYNC2H1	0.270	2.19E-05
ENSG00000173276	ZBTB21	0.270	3.47E-06
ENSG00000111731	C2CD5	0.270	1.46E-04
ENSG00000166311	SMPD1	0.269	2.03E-04
ENSG00000206538	VGLL3	0.269	9.77E-04
ENSG00000077514	POLD3	0.269	3.34E-06
ENSG00000130749	ZC3H4	0.269	1.24E-06
ENSG00000143702	CEP170	0.269	3.81E-06
ENSG00000152133	GPATCH11	0.269	6.14E-05
ENSG00000136205	TNS3	0.269	6.67E-07
ENSG00000076513	ANKRD13A	0.269	2.22E-05
ENSG00000111674	ENO2	0.269	2.27E-03
ENSG00000138439	FAM117B	0.269	2.71E-03
ENSG00000102098	SCML2	0.269	5.39E-03
ENSG00000156011	PSD3	0.268	2.96E-06
ENSG00000124374	PAIP2B	0.268	3.95E-02

ENSG00000183496	MEX3B	0.268	4.20E-02
ENSG00000213859	KCTD11	0.268	4.83E-06
ENSG00000170873	MTSS1	0.268	4.33E-07
ENSG00000089876	DHX32	0.268	5.49E-05
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ENSG00000105662	CRTC1	0.268	6.24E-03
ENSG00000091732	ZC3HC1	0.268	2.02E-04
ENSG00000197077	KIAA1671	0.268	2.92E-08
ENSG00000188026	RILPL1	0.267	1.14E-03
ENSG00000154229	PRKCA	0.267	1.40E-04
ENSG00000134058	CDK7	0.267	2.74E-06
ENSG00000069702	TGFBR3	0.267	2.99E-03
ENSG00000162892	IL24	0.267	1.33E-03
ENSG00000166529	ZSCAN21	0.267	1.37E-03
ENSG00000011143	MKS1	0.266	7.07E-04
ENSG00000154040	CABYR	0.266	1.17E-02
ENSG00000117222	RBBP5	0.266	5.66E-06
ENSG00000124191	TOX2	0.266	1.45E-02
ENSG00000141699	FAM134C	0.266	2.50E-05
ENSG00000133059	DSTYK	0.266	4.08E-05
ENSG00000174282	ZBTB4	0.266	1.25E-07
ENSG00000196187	TMEM63A	0.265	6.37E-04
ENSG00000136925	TSTD2	0.265	4.24E-05
ENSG00000099968	BCL2L13	0.265	5.34E-07
ENSG00000081019	RSBN1	0.265	4.22E-04
ENSG00000166912	MTMR10	0.265	8.81E-05
ENSG00000088808	PPP1R13B	0.265	3.94E-05
ENSG00000274211	SOCS7	0.265	8.41E-05
ENSG00000235437	LINC01278	0.265	3.22E-04
ENSG00000144283	PKP4	0.264	7.38E-08
ENSG00000088970	KIZ	0.264	6.34E-04
ENSG00000189042	ZNF567	0.264	4.81E-03
ENSG00000168003	SLC3A2	0.264	2.94E-07
ENSG00000163867	ZMYM6	0.264	3.95E-02
ENSG00000168246	UBTD2	0.264	3.68E-05
ENSG00000159592	GPBP1L1	0.264	3.21E-07
ENSG00000158555	GDPD5	0.264	3.84E-02
ENSG00000068784	SRBD1	0.264	7.21E-05
ENSG00000100601	ALKBH1	0.264	1.28E-03
ENSG00000157827	FMNL2	0.264	1.08E-06
ENSG00000003393	ALS2	0.264	1.07E-06
ENSG00000274020	LINC01138	0.264	5.02E-02
ENSG00000139083	ETV6	0.264	2.98E-06

ENSG00000120733	KDM3B	0.263	8.00E-08
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ENSG00000160190	SLC37A1	0.263	6.05E-03
ENSG00000149636	DSN1	0.263	8.35E-07
ENSG00000196456	ZNF775	0.263	4.05E-02
ENSG00000198707	CEP290	0.263	1.65E-04
ENSG00000154310	TNIK	0.263	2.04E-02
ENSG00000047578	KIAA0556	0.263	1.54E-04
ENSG00000148680	HTR7	0.263	3.19E-03
ENSG00000186260	MKL2	0.263	3.02E-06
ENSG00000100246	DNAL4	0.263	9.15E-03
ENSG00000165699	TSC1	0.263	1.41E-05
ENSG00000198742	SMURF1	0.263	4.62E-07
ENSG00000155974	GRIP1	0.262	1.71E-02
ENSG00000155621	C9orf85	0.262	1.13E-03
ENSG00000136940	PDCL	0.262	9.36E-05
ENSG00000122257	RBBP6	0.262	5.23E-08
ENSG00000117153	KLHL12	0.262	8.20E-06
ENSG00000183137	CEP57L1	0.262	5.79E-04
ENSG00000163611	SPICE1	0.262	1.70E-03
ENSG00000009413	REV3L	0.262	3.39E-06
ENSG00000162236	STX5	0.261	5.17E-05
ENSG00000235954	TTC28-AS1	0.261	4.88E-03
ENSG00000246067	RAB30-AS1	0.261	3.64E-02
ENSG00000111877	MCM9	0.261	3.03E-03
ENSG00000181315	ZNF322	0.261	4.03E-04
ENSG00000151553	FAM160B1	0.261	2.43E-04
ENSG00000184205	TSPYL2	0.261	1.06E-05
ENSG00000116128	BCL9	0.261	8.74E-05
ENSG00000188554	NBR1	0.261	1.93E-07
ENSG00000198270	TMEM116	0.260	1.61E-02
ENSG00000167074	TEF	0.260	3.49E-03
ENSG00000123427	METTL21B	0.260	3.30E-02
ENSG00000163517	HDAC11	0.260	4.92E-03
ENSG00000092140	G2E3	0.260	3.42E-04
ENSG00000084444	FAM234B	0.260	2.11E-02
ENSG00000196074	SYCP2	0.260	2.43E-04
ENSG00000164306	PRIMPOL	0.260	3.32E-03
ENSG00000145908	ZNF300	0.260	3.40E-04
ENSG00000175183	CSRP2	0.260	1.65E-03
ENSG00000163510	CWC22	0.260	4.27E-06
ENSG00000244879	GABPB1-AS1	0.260	7.22E-04
ENSG00000147439	BIN3	0.259	2.32E-04

ENSG00000111790	FGFR1OP2	0.259	1.37E-04
ENSG00000137941	TTLL7	0.259	3.31E-02
ENSG00000136560	TANK	0.259	7.44E-06
ENSG00000107938	EDRF1	0.259	3.21E-05
ENSG00000128805	ARHGAP22	0.258	4.54E-02
ENSG00000150477	KIAA1328	0.258	2.42E-03
ENSG00000115042	FAHD2A	0.258	3.89E-03
ENSG00000181135	ZNF707	0.258	2.11E-03
ENSG00000055208	TAB2	0.258	6.79E-08
ENSG00000182541	LIMK2	0.258	1.09E-07
ENSG00000108669	CYTH1	0.258	1.76E-06
ENSG00000154079	SDHAF4	0.258	3.89E-02
ENSG00000196526	AFAP1	0.258	4.48E-05
ENSG00000154429	CCSAP	0.258	1.44E-03
ENSG00000141013	GAS8	0.258	7.45E-04
ENSG00000102804	TSC22D1	0.258	2.74E-08
ENSG00000026559	KCNG1	0.258	5.01E-03
ENSG00000162409	PRKAA2	0.257	3.94E-02
ENSG00000204599	TRIM39	0.257	1.13E-03
ENSG00000230724	LINC01001	0.257	1.26E-03
ENSG00000158480	SPATA2	0.257	1.66E-04
ENSG00000024526	DEPDC1	0.257	1.70E-05
ENSG00000135090	TAOK3	0.257	3.89E-06
ENSG00000125089	SH3TC1	0.257	4.63E-06
ENSG00000162738	VANGL2	0.257	9.26E-04
ENSG00000031003	FAM13B	0.257	1.02E-05
ENSG00000197256	KANK2	0.257	9.18E-06
ENSG00000126091	ST3GAL3	0.257	6.49E-03
ENSG00000115271	GCA	0.256	1.05E-02
ENSG00000163683	SMIM14	0.256	2.27E-03
ENSG00000076053	RBM7	0.256	2.34E-04
ENSG00000171310	CHST11	0.256	4.18E-05
ENSG00000170260	ZNF212	0.256	1.92E-03
ENSG00000145703	IQGAP2	0.255	7.31E-03
ENSG00000181852	RNF41	0.255	5.66E-06
ENSG00000205808	PLPP6	0.255	2.60E-02
ENSG00000052795	FNIP2	0.255	1.35E-03
ENSG00000162714	ZNF496	0.255	2.50E-05
ENSG00000100731	PCNX	0.255	3.62E-06
ENSG00000164695	CHMP4C	0.255	3.60E-04
ENSG00000114626	ABTB1	0.255	1.60E-02
ENSG00000255529	POLR2M	0.255	3.37E-03
ENSG00000196455	PIK3R4	0.255	1.86E-05

ENSG00000112290	WASF1	0.254	9.77E-06
ENSG00000185946	RNPC3	0.254	1.93E-03
ENSG00000198945	L3MBTL3	0.254	1.34E-03
ENSG00000148950	IMMP1L	0.254	3.79E-02
ENSG00000143303	RRNAD1	0.254	1.78E-03
ENSG00000172795	DCP2	0.253	1.40E-04
ENSG00000187535	IFT140	0.253	1.32E-02
ENSG00000124224	PPP4R1L	0.253	1.18E-04
ENSG00000122966	CIT	0.253	4.47E-07
ENSG00000160200	CBS	0.253	3.34E-03
ENSG00000055917	PUM2	0.253	1.24E-06
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ENSG00000014123	UFL1	0.253	3.93E-05
ENSG00000116525	TRIM62	0.253	4.73E-03
ENSG00000147421	HMBOX1	0.252	6.26E-04
ENSG00000173542	MOB1B	0.252	9.31E-06
ENSG00000137185	ZSCAN9	0.252	9.65E-03
ENSG00000174373	RALGAPA1	0.252	9.99E-06
ENSG00000130695	CEP85	0.251	5.89E-06
ENSG00000170786	SDR16C5	0.251	2.67E-02
ENSG00000115902	SLC1A4	0.251	1.70E-05
ENSG00000196678	ERI2	0.251	2.08E-04
ENSG00000102401	ARMCX3	0.251	2.06E-04
ENSG00000110046	ATG2A	0.251	1.16E-04
ENSG00000040933	INPP4A	0.250	3.36E-04
ENSG00000117114	ADGRL2	0.250	1.70E-05
ENSG00000164329	PAPD4	0.250	6.46E-05
ENSG00000158793	NIT1	0.250	1.75E-04
ENSG00000015133	CCDC88C	0.250	2.88E-05
ENSG00000168918	INPP5D	0.250	8.08E-03
ENSG00000087510	TFAP2C	0.250	1.30E-02
ENSG00000068885	IFT80	0.250	1.27E-02
ENSG00000198586	TLK1	0.250	3.62E-06
ENSG00000006453	BAIAP2L1	0.249	3.39E-07
ENSG00000108587	GOSR1	0.249	1.02E-06
ENSG00000169410	PTPN9	0.249	8.14E-06
ENSG00000101343	CRNKL1	0.249	8.85E-06
ENSG00000170734	POLH	0.249	1.17E-04
ENSG00000152104	PTPN14	0.249	6.28E-08
ENSG00000139289	PHLDA1	0.249	1.44E-07
ENSG00000105321	CCDC9	0.249	1.53E-03
ENSG00000076685	NT5C2	0.248	9.88E-06
ENSG00000204406	MBD5	0.248	1.10E-04

ENSG00000166821	PEX11A	0.248	4.50E-02
ENSG00000112742	TTK	0.248	3.81E-06
ENSG00000196628	TCF4	0.248	3.64E-05
ENSG00000083093	PALB2	0.248	4.14E-05
ENSG00000237438	CECR7	0.247	3.26E-03
ENSG00000165914	TTC7B	0.247	5.16E-03
ENSG00000130517	PGPEP1	0.247	2.34E-02
ENSG00000136720	HS6ST1	0.247	1.29E-04
ENSG00000129007	CALML4	0.247	1.73E-02
ENSG00000119408	NEK6	0.247	1.10E-05
ENSG00000027075	PRKCH	0.247	2.01E-03
ENSG00000163320	CGGBP1	0.247	2.70E-05
ENSG00000143952	VPS54	0.247	4.41E-04
ENSG00000163349	HIPK1	0.247	4.79E-07
ENSG00000184381	PLA2G6	0.246	4.67E-02
ENSG00000158296	SLC13A3	0.246	3.63E-03
ENSG00000196236	XPNPEP3	0.246	9.40E-04
ENSG00000089123	TASP1	0.246	1.09E-02
ENSG00000278540	ACACA	0.246	7.13E-08
ENSG00000171365	CLCN5	0.246	7.08E-03
ENSG00000083535	PIBF1	0.246	4.58E-04
ENSG00000187189	TSPYL4	0.246	8.57E-05
ENSG00000185924	RTN4RL1	0.246	3.44E-02
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ENSG00000092208	GEMIN2	0.245	8.50E-03
ENSG00000132549	VPS13B	0.245	1.41E-05
ENSG00000136147	PHF11	0.245	1.40E-02
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ENSG00000136935	GOLGA1	0.245	9.80E-05
ENSG00000204149	AGAP6	0.244	1.37E-02
ENSG00000160445	ZER1	0.244	5.14E-05
ENSG00000175662	TOM1L2	0.244	2.05E-04
ENSG00000118689	FOXO3	0.244	5.14E-07
ENSG00000196459	TRAPPC2	0.244	2.86E-02
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ENSG00000111077	TNS2	0.243	9.99E-06
ENSG00000134899	ERCC5	0.243	6.57E-04
ENSG00000076321	KLHL20	0.243	5.02E-04
ENSG00000113838	TBCCD1	0.243	1.97E-03
ENSG00000137760	ALKBH8	0.243	1.11E-03
ENSG00000186625	KATNA1	0.243	2.66E-04

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ENSG00000174705	SH3PXD2B	0.242	2.32E-07
ENSG00000144566	RAB5A	0.242	1.64E-06
ENSG00000227345	PARG	0.242	4.62E-05
ENSG00000158717	RNF166	0.242	2.39E-03
ENSG00000146463	ZMYM4	0.242	2.87E-06
ENSG00000152520	PAN3	0.241	1.17E-04
ENSG00000073849	ST6GAL1	0.241	1.82E-03
ENSG00000210082	MT-RNR2	0.241	7.73E-07
ENSG00000066468	FGFR2	0.241	5.01E-03
ENSG00000123485	HJURP	0.241	1.61E-06
ENSG00000088356	PDRG1	0.241	4.45E-04
ENSG00000153767	GTF2E1	0.241	6.04E-04
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ENSG00000148400	NOTCH1	0.241	3.17E-05
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ENSG00000145777	TSLP	0.240	3.10E-02
ENSG00000174606	ANGEL2	0.240	3.79E-04
ENSG00000143578	CREB3L4	0.240	3.29E-02
ENSG00000172661	FAM21C	0.239	1.36E-04
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ENSG00000186951	PPARA	0.239	1.91E-03
ENSG00000130158	DOCK6	0.239	7.52E-05
ENSG00000166167	BTRC	0.239	6.26E-05
ENSG00000107186	MPDZ	0.239	1.28E-03
ENSG00000169519	METTL15	0.238	7.77E-03
ENSG00000143458	GABPB2	0.238	3.61E-04
ENSG00000109819	PPARGC1A	0.238	1.89E-02
ENSG00000128731	HERC2	0.238	1.11E-05
ENSG00000028839	TBPL1	0.238	8.58E-04
ENSG00000114735	HEMK1	0.238	4.09E-03
ENSG00000162601	MYSM1	0.238	4.89E-04
ENSG00000138162	TACC2	0.238	1.12E-05
ENSG00000132359	RAP1GAP2	0.237	1.56E-05
ENSG00000162390	ACOT11	0.237	2.53E-03
ENSG00000187908	DMBT1	0.237	2.12E-02
ENSG00000129315	CCNT1	0.237	1.37E-06
ENSG00000214517	PPME1	0.237	2.60E-06
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ENSG00000003137	CYP26B1	0.236	1.18E-02

ENSG00000116095	PLEKHA3	0.236	1.81E-03
ENSG00000162642	C1orf52	0.236	2.39E-03
ENSG00000181555	SETD2	0.236	1.79E-07
ENSG00000173226	IQCB1	0.236	1.36E-03
ENSG00000140548	ZNF710	0.236	9.78E-05
ENSG00000183666	GUSBP1	0.236	1.82E-02
ENSG00000138286	FAM149B1	0.236	6.52E-03
ENSG00000100154	TTC28	0.235	4.71E-04
ENSG00000171503	ETFDH	0.235	9.80E-04
ENSG00000227036	LINC00511	0.235	3.29E-04
ENSG00000076641	PAG1	0.235	3.45E-02
ENSG00000089335	ZNF302	0.235	6.06E-03
ENSG00000103111	MON1B	0.235	5.44E-06
ENSG00000101412	E2F1	0.235	7.63E-05
ENSG00000185798	WDR53	0.235	1.14E-03
ENSG00000116793	PHTF1	0.235	5.90E-03
ENSG00000150457	LATS2	0.234	3.26E-04
ENSG00000066739	ATG2B	0.234	2.01E-05
ENSG00000036549	ZZZ3	0.234	1.22E-06
ENSG00000154767	XPC	0.234	6.97E-06
ENSG00000142794	NBPF3	0.234	1.96E-03
ENSG00000198964	SGMS1	0.234	6.35E-04
ENSG00000115661	STK16	0.233	2.88E-04
ENSG00000106078	COBL	0.233	1.80E-03
ENSG00000132334	PTPRE	0.233	1.68E-05
ENSG00000075240	GRAMD4	0.233	2.65E-02
ENSG00000108469	RECQL5	0.233	6.77E-05
ENSG00000122741	DCAF10	0.233	2.02E-04
ENSG00000141040	ZNF287	0.233	3.54E-02
ENSG00000168538	TRAPPC11	0.233	6.72E-05
ENSG00000100744	GSKIP	0.232	1.99E-03
ENSG00000204842	ATXN2	0.232	7.40E-06
ENSG00000198121	LPAR1	0.232	9.79E-04
ENSG00000155252	PI4K2A	0.232	6.15E-06
ENSG00000110921	MVK	0.232	2.69E-04
ENSG00000168411	RFWD3	0.232	2.64E-07
ENSG00000151718	WWC2	0.232	6.65E-05
ENSG00000141428	C18orf21	0.232	3.93E-03
ENSG00000174718	KIAA1551	0.231	1.34E-04
ENSG00000177570	SAMD12	0.231	9.87E-03
ENSG00000166510	CCDC68	0.231	1.16E-02
ENSG00000111817	DSE	0.231	5.51E-07
ENSG00000135953	MFSD9	0.231	6.49E-03

ENSG00000198948	MFAP3L	0.230	1.02E-02
ENSG00000196712	NF1	0.230	5.60E-07
ENSG00000109118	PHF12	0.229	8.24E-06
ENSG00000108821	COL1A1	0.229	1.07E-03
ENSG00000065457	ADAT1	0.229	2.33E-04
ENSG00000165782	TMEM55B	0.229	1.40E-03
ENSG00000030419	IKZF2	0.229	1.52E-02
ENSG00000163482	STK36	0.229	4.30E-04
ENSG00000170832	USP32	0.229	2.49E-06
ENSG00000152348	ATG10	0.229	2.12E-02
ENSG00000117614	SYF2	0.228	5.90E-04
ENSG00000100483	VCPKMT	0.228	2.04E-02
ENSG00000131652	THOC6	0.228	1.94E-03
ENSG00000067369	TP53BP1	0.228	2.53E-05
ENSG00000166173	LARP6	0.228	1.76E-02
ENSG00000122512	PMS2	0.228	9.53E-04
ENSG00000153294	ADGRF4	0.228	2.77E-03
ENSG00000215190	LINC00680	0.228	4.75E-02
ENSG00000166263	STXBP4	0.228	1.52E-02
ENSG00000157212	PAXIP1	0.228	9.62E-05
ENSG00000099910	KLHL22	0.227	3.61E-02
ENSG00000183814	LIN9	0.227	3.01E-03
ENSG00000204231	RXRB	0.227	2.77E-04
ENSG00000136874	STX17	0.227	2.57E-03
ENSG00000100014	SPECC1L	0.227	1.68E-04
ENSG00000176225	RTTN	0.227	1.75E-04
ENSG00000117650	NEK2	0.226	1.56E-04
ENSG00000164631	ZNF12	0.226	7.10E-04
ENSG00000125629	INSIG2	0.226	5.06E-03
ENSG00000154640	BTG3	0.226	8.99E-05
ENSG00000163743	RCHY1	0.226	2.15E-02
ENSG00000243335	KCTD7	0.226	5.08E-02
ENSG00000175309	PHYKPL	0.226	9.12E-03
ENSG00000124882	EREG	0.225	7.09E-05
ENSG00000105865	DUS4L	0.225	1.05E-02
ENSG00000165359	DDX26B	0.225	1.35E-03
ENSG00000075303	SLC25A40	0.225	1.85E-03
ENSG00000177614	PGBD5	0.225	2.01E-02
ENSG00000100814	CCNB1IP1	0.225	3.65E-04
ENSG00000095787	WAC	0.225	8.71E-08
ENSG00000177380	PPFIA3	0.225	2.80E-02
ENSG00000206573	THUMPD3-AS1	0.225	1.24E-02
ENSG00000097046	CDC7	0.225	1.90E-05

ENSG00000162819	BROX	0.225	1.97E-04
ENSG00000113790	EHHADH	0.224	1.06E-02
ENSG00000156639	ZFAND3	0.224	1.69E-05
ENSG00000143740	SNAP47	0.224	2.34E-03
ENSG00000105173	CCNE1	0.224	5.78E-03
ENSG00000047188	YTHDC2	0.224	2.20E-05
ENSG00000047249	ATP6V1H	0.223	7.02E-04
ENSG00000119720	NRDE2	0.223	5.24E-03
ENSG00000137266	SLC22A23	0.223	7.01E-05
ENSG00000083290	ULK2	0.223	2.15E-03
ENSG00000152284	TCF7L1	0.223	1.06E-03
ENSG00000180385	EMC3-AS1	0.223	9.27E-03
ENSG00000104343	UBE2W	0.223	2.63E-03
ENSG00000134698	AGO4	0.223	5.28E-03
ENSG00000143228	NUF2	0.223	2.68E-04
ENSG00000162378	ZYG11B	0.223	2.10E-04
ENSG00000014164	ZC3H3	0.222	1.38E-03
ENSG00000165671	NSD1	0.222	4.78E-07
ENSG00000180336	C17orf104	0.222	3.51E-03
ENSG00000150764	DIXDC1	0.222	2.79E-05
ENSG00000138942	RNF185	0.222	6.53E-05
ENSG00000187583	PLEKHN1	0.222	1.46E-02
ENSG00000101191	DIDO1	0.222	1.08E-06
ENSG00000160741	CRTC2	0.222	6.50E-05
ENSG00000185591	SP1	0.222	8.95E-07
ENSG00000130772	MED18	0.222	1.60E-02
ENSG00000148343	FAM73B	0.222	3.96E-03
ENSG00000154914	USP43	0.221	1.79E-02
ENSG00000067606	PRKCZ	0.221	1.42E-03
ENSG00000135541	AHI1	0.221	1.11E-02
ENSG00000120053	GOT1	0.221	7.92E-05
ENSG00000149231	CCDC82	0.221	7.01E-04
ENSG00000165219	GAPVD1	0.221	1.59E-06
ENSG00000149531	FRG1BP	0.221	1.17E-02
ENSG00000105829	BET1	0.221	1.35E-02
ENSG00000171469	ZNF561	0.221	3.39E-04
ENSG00000114416	FXR1	0.221	2.03E-06
ENSG00000140830	TXNL4B	0.221	1.86E-03
ENSG00000157077	ZFYVE9	0.221	5.02E-04
ENSG00000138592	USP8	0.221	6.15E-06
ENSG00000090238	YPEL3	0.221	1.65E-02
ENSG00000089351	GRAMD1A	0.221	5.25E-04
ENSG00000135931	ARMC9	0.220	6.52E-03

ENSG00000197343	ZNF655	0.220	9.26E-05
ENSG00000123200	ZC3H13	0.220	7.86E-07
ENSG00000075651	PLD1	0.220	2.52E-03
ENSG00000058799	YIPF1	0.220	1.34E-03
ENSG00000163605	PPP4R2	0.220	4.50E-05
ENSG00000115977	AAK1	0.219	2.19E-05
ENSG00000105993	DNAJB6	0.219	5.03E-06
ENSG00000100888	CHD8	0.219	1.07E-06
ENSG00000196739	COL27A1	0.219	5.56E-05
ENSG00000083544	TDRD3	0.219	2.30E-03
ENSG00000104936	DMPK	0.219	2.98E-03
ENSG00000135127	CCDC64	0.219	8.36E-03
ENSG00000266338	NBPF15	0.218	4.22E-03
ENSG00000132846	ZBED3	0.218	6.86E-04
ENSG00000177054	ZDHHC13	0.218	3.00E-03
ENSG00000001631	KRIT1	0.218	2.57E-04
ENSG00000086102	NFX1	0.217	4.15E-06
ENSG00000188315	C3orf62	0.217	1.51E-02
ENSG00000114473	IQCG	0.217	2.36E-02
ENSG00000135845	PIGC	0.217	5.20E-03
ENSG00000134757	DSG3	0.216	1.34E-05
ENSG00000112592	TBP	0.216	7.04E-04
ENSG00000006695	COX10	0.216	2.39E-03
ENSG00000147548	WHSC1L1	0.216	2.53E-06
ENSG00000156860	FBRS	0.216	2.31E-05
ENSG00000082512	TRAF5	0.216	3.80E-02
ENSG00000125945	ZNF436	0.216	9.94E-04
ENSG00000100461	RBM23	0.216	8.73E-06
ENSG00000100105	PATZ1	0.216	1.08E-03
ENSG00000111727	HCFC2	0.216	4.92E-03
ENSG00000100099	HPS4	0.215	2.49E-05
ENSG00000165006	UBAP1	0.215	4.63E-06
ENSG00000163026	C2orf44	0.215	4.13E-03
ENSG00000130299	GTPBP3	0.215	5.86E-04
ENSG00000176095	IP6K1	0.215	2.27E-04
ENSG00000182095	TNRC18	0.215	2.49E-05
ENSG00000172845	SP3	0.215	2.45E-05
ENSG00000159579	RSPRY1	0.215	3.12E-04
ENSG00000164181	ELOVL7	0.215	5.33E-03
ENSG00000126456	IRF3	0.215	2.89E-04
ENSG00000058091	CDK14	0.215	3.36E-04
ENSG00000171723	GPHN	0.215	1.62E-03
ENSG00000107560	RAB11FIP2	0.214	3.90E-03

ENSG00000100284	TOM1	0.214	4.16E-03
ENSG00000112851	ERBB2IP	0.214	4.69E-06
ENSG00000072518	MARK2	0.214	9.76E-06
ENSG00000107897	ACBD5	0.214	2.07E-03
ENSG00000121879	PIK3CA	0.214	3.81E-04
ENSG00000146457	WTAP	0.214	7.88E-06
ENSG00000106351	AGFG2	0.214	1.79E-02
ENSG00000141510	TP53	0.214	1.01E-05
ENSG00000118193	KIF14	0.214	4.64E-05
ENSG00000166261	ZNF202	0.214	5.08E-03
ENSG00000001461	NIPAL3	0.214	1.13E-05
ENSG00000127603	MACF1	0.214	3.33E-06
ENSG00000010539	ZNF200	0.213	9.79E-03
ENSG00000198862	LTN1	0.213	3.53E-05
ENSG00000023330	ALAS1	0.213	4.09E-05
ENSG00000121741	ZMYM2	0.213	1.07E-05
ENSG00000184465	WDR27	0.213	2.22E-03
ENSG00000114331	ACAP2	0.213	1.43E-04
ENSG00000149311	ATM	0.213	3.29E-04
ENSG00000233621	LINC01137	0.213	5.04E-02
ENSG00000105443	CYTH2	0.213	1.04E-04
ENSG00000179104	TMTC2	0.213	3.45E-02
ENSG00000155545	MIER3	0.213	6.30E-05
ENSG00000198807	PAX9	0.213	1.70E-02
ENSG00000126561	STAT5A	0.213	3.88E-02
ENSG00000134278	SPIRE1	0.213	2.02E-05
ENSG00000110427	KIAA1549L	0.213	1.03E-03
ENSG00000074211	PPP2R2C	0.213	4.86E-02
ENSG00000164751	PEX2	0.212	3.55E-03
ENSG00000172123	SLFN12	0.212	3.61E-02
ENSG00000163629	PTPN13	0.212	1.30E-04
ENSG00000165105	RASEF	0.212	1.92E-02
ENSG00000140006	WDR89	0.212	1.94E-03
ENSG00000148634	HERC4	0.212	2.90E-04
ENSG00000132321	IQCA1	0.212	5.54E-03
ENSG00000198919	DZIP3	0.212	2.93E-02
ENSG00000164294	GPX8	0.212	1.57E-04
ENSG00000155508	CNOT8	0.212	9.41E-05
ENSG00000134574	DDB2	0.211	2.45E-04
ENSG00000108474	PIGL	0.211	8.27E-03
ENSG00000156958	GALK2	0.211	6.90E-03
ENSG00000079691	LRRC16A	0.211	1.57E-04
ENSG00000103021	CCDC113	0.211	1.62E-03

ENSG00000183323	CCDC125	0.211	1.21E-02
ENSG00000106392	C1GALT1	0.211	4.14E-04
ENSG00000116679	IVNS1ABP	0.211	1.99E-05
ENSG00000008300	CELSR3	0.211	5.28E-04
ENSG00000125962	ARMCX5	0.211	2.71E-02
ENSG00000070018	LRP6	0.210	4.46E-05
ENSG00000129292	PHF20L1	0.210	2.95E-05
ENSG00000180182	MED14	0.210	1.87E-05
ENSG00000145734	BDP1	0.210	3.33E-06
ENSG00000225470	JPX	0.210	2.30E-02
ENSG00000174136	RGMB	0.210	1.79E-05
ENSG00000105778	AVL9	0.210	1.44E-04
ENSG00000091157	WDR7	0.210	9.11E-04
ENSG00000189337	KAZN	0.209	4.62E-02
ENSG00000060237	WNK1	0.209	1.96E-07
ENSG00000140534	TICRR	0.209	1.71E-04
ENSG00000112367	FIG4	0.209	4.97E-02
ENSG00000156299	TIAM1	0.209	5.05E-03
ENSG00000174796	THAP6	0.209	3.05E-02
ENSG00000131381	RBSN	0.208	8.39E-05
ENSG00000171320	ESCO2	0.208	9.31E-04
ENSG00000113615	SEC24A	0.208	1.39E-05
ENSG00000157985	AGAP1	0.208	1.08E-04
ENSG00000197372	ZNF675	0.208	3.24E-02
ENSG00000257923	CUX1	0.208	1.39E-05
ENSG00000182606	TRAK1	0.208	9.70E-06
ENSG00000241058	NSUN6	0.208	1.32E-02
ENSG00000143363	PRUNE	0.208	8.69E-03
ENSG00000140598	EFTUD1	0.207	7.85E-04
ENSG00000131669	NINJ1	0.207	1.18E-03
ENSG00000160447	PKN3	0.207	2.62E-02
ENSG00000145246	ATP10D	0.207	9.16E-04
ENSG00000163633	C4orf36	0.207	4.65E-02
ENSG00000155313	USP25	0.206	1.04E-04
ENSG00000183765	CHEK2	0.206	1.28E-03
ENSG00000101624	CEP76	0.206	6.51E-03
ENSG00000114742	WDR48	0.206	2.79E-04
ENSG00000140254	DUOXA1	0.206	1.50E-02
ENSG00000174564	IL20RB	0.205	4.17E-06
ENSG00000072195	SPEG	0.205	2.12E-02
ENSG00000103540	CCP110	0.205	9.52E-04
ENSG00000143493	INTS7	0.205	4.12E-05
ENSG00000167182	SP2	0.205	7.47E-04

ENSG00000074657	ZNF532	0.205	1.14E-05
ENSG00000125863	MKKS	0.205	5.19E-05
ENSG00000165525	NEMF	0.205	5.96E-05
ENSG00000179833	SERTAD2	0.204	8.27E-05
ENSG00000173548	SNX33	0.204	2.96E-05
ENSG00000135250	SRPK2	0.204	3.80E-05
ENSG00000107643	MAPK8	0.204	5.03E-04
ENSG00000155744	FAM126B	0.204	4.59E-03
ENSG00000038219	BOD1L1	0.204	1.01E-05
ENSG00000180543	TSPYL5	0.204	1.22E-03
ENSG00000004766	VPS50	0.204	3.22E-03
ENSG00000013375	PGM3	0.204	1.94E-04
ENSG00000072736	NFATC3	0.203	3.84E-04
ENSG00000109466	KLHL2	0.203	1.86E-03
ENSG00000131845	ZNF304	0.203	9.33E-03
ENSG00000048471	SNX29	0.203	1.67E-03
ENSG00000099290	FAM21A	0.203	2.88E-04
ENSG00000102226	USP11	0.203	4.37E-04
ENSG00000136504	KAT7	0.203	4.12E-05
ENSG00000119772	DNMT3A	0.203	7.34E-03
ENSG00000166848	TERF2IP	0.203	1.22E-04
ENSG00000068971	PPP2R5B	0.203	4.77E-03
ENSG00000169018	FEM1B	0.202	1.20E-04
ENSG00000124688	MAD2L1BP	0.202	3.26E-03
ENSG00000176142	TMEM39A	0.202	2.85E-03
ENSG00000213762	ZNF134	0.202	5.10E-03
ENSG00000023171	GRAMD1B	0.202	1.17E-03
ENSG00000151466	SCLT1	0.202	2.91E-03
ENSG00000123607	TTC21B	0.202	8.49E-03
ENSG00000115112	TFCP2L1	0.202	8.01E-06
ENSG00000165490	DDIAS	0.201	2.48E-04
ENSG00000152061	RABGAP1L	0.201	5.50E-04
ENSG00000198420	TCAF1	0.201	3.25E-05
ENSG00000162542	TMCO4	0.201	1.08E-02
ENSG00000115760	BIRC6	0.201	6.65E-06
ENSG00000105879	CBLL1	0.201	3.89E-05
ENSG00000128923	FAM63B	0.201	3.25E-04
ENSG00000128915	ICE2	0.201	2.01E-04
ENSG00000140577	CRTC3	0.200	8.79E-04
ENSG00000178397	FAM220A	0.200	2.95E-02
ENSG00000169249	ZRSR2	0.200	1.78E-02
ENSG00000072415	MPP5	0.200	4.24E-04
ENSG00000172943	PHF8	0.200	2.58E-04

ENSG00000171316	CHD7	0.200	3.18E-04
ENSG00000146094	DOK3	0.200	1.21E-02
ENSG00000155906	RMND1	0.200	1.19E-02
ENSG00000221926	TRIM16	0.200	1.46E-02
ENSG00000101888	NXT2	0.200	1.69E-02
ENSG00000008869	HEATR5B	0.199	1.82E-03
ENSG00000196323	ZBTB44	0.199	2.81E-04
ENSG00000151491	EPS8	0.199	1.34E-03
ENSG00000148218	ALAD	0.199	1.15E-03
ENSG00000085382	HACE1	0.199	1.56E-02
ENSG00000079215	SLC1A3	0.199	9.74E-04
ENSG00000154556	SORBS2	0.199	2.48E-03
ENSG00000163788	SNRK	0.199	4.31E-04
ENSG00000166272	WBP1L	0.199	9.19E-05
ENSG00000132466	ANKRD17	0.198	9.01E-07
ENSG00000133422	MORC2	0.198	2.89E-04
ENSG00000105738	SIPA1L3	0.198	5.70E-04
ENSG00000083642	PDS5B	0.198	1.35E-04
ENSG00000154358	OBSCN	0.198	3.99E-03
ENSG00000127946	HIP1	0.198	1.05E-03
ENSG00000108352	RAPGEFL1	0.197	1.46E-02
ENSG00000198909	MAP3K3	0.197	8.94E-04
ENSG00000146576	C7orf26	0.197	7.26E-03
ENSG00000131089	ARHGEF9	0.197	1.49E-02
ENSG00000125482	TTF1	0.197	3.12E-03
ENSG00000079482	OPHN1	0.197	2.37E-02
ENSG00000131979	GCH1	0.197	3.02E-03
ENSG00000104375	STK3	0.197	5.27E-04
ENSG00000119509	INVS	0.197	4.54E-03
ENSG00000128513	POT1	0.197	3.05E-03
ENSG00000154839	SKA1	0.197	1.46E-04
ENSG00000160326	SLC2A6	0.197	1.31E-02
ENSG00000064999	ANKS1A	0.196	7.21E-04
ENSG00000159899	NPR2	0.196	3.07E-02
ENSG00000090612	ZNF268	0.196	9.71E-03
ENSG00000056972	TRAF3IP2	0.196	1.52E-05
ENSG00000144747	TMF1	0.196	2.09E-04
ENSG00000188419	CHM	0.196	7.64E-04
ENSG00000053770	AP5M1	0.196	2.36E-04
ENSG00000198408	MGEA5	0.195	3.48E-06
ENSG00000106089	STX1A	0.195	2.26E-03
ENSG00000100221	JOSD1	0.195	1.49E-05
ENSG00000166925	TSC22D4	0.195	1.49E-03

ENSG00000140320	BAHD1	0.195	1.11E-03
ENSG00000167670	CHAF1A	0.195	1.95E-05
ENSG00000182208	MOB2	0.194	6.11E-03
ENSG00000196781	TLE1	0.194	3.88E-05
ENSG00000155330	C16orf87	0.194	3.64E-02
ENSG00000139182	CLSTN3	0.194	5.50E-03
ENSG00000128272	ATF4	0.194	4.63E-07
ENSG00000128607	KLHDC10	0.194	3.18E-04
ENSG00000121281	ADCY7	0.193	3.57E-03
ENSG00000269556	TMEM185A	0.193	3.19E-02
ENSG00000214193	SH3D21	0.193	2.33E-03
ENSG00000058272	PPP1R12A	0.193	4.73E-05
ENSG00000123815	ADCK4	0.193	8.75E-03
ENSG00000150776	C11orf57	0.193	7.52E-04
ENSG00000133466	C1QTNF6	0.193	3.84E-02
ENSG00000004975	DVL2	0.193	2.18E-04
ENSG00000136451	VEZF1	0.193	8.41E-05
ENSG00000196498	NCOR2	0.193	6.09E-04
ENSG00000161533	ACOX1	0.193	1.89E-03
ENSG00000125885	MCM8	0.193	3.93E-05
ENSG00000203880	PCMTD2	0.192	1.51E-03
ENSG00000064313	TAF2	0.192	2.86E-04
ENSG00000170802	FOXN2	0.192	8.27E-03
ENSG00000136643	RPS6KC1	0.192	1.15E-02
ENSG00000132471	WBP2	0.192	9.34E-04
ENSG00000130347	RTN4IP1	0.192	4.57E-02
ENSG00000104133	SPG11	0.192	3.59E-04
ENSG00000167470	MIDN	0.192	1.35E-04
ENSG00000101871	MID1	0.191	1.60E-03
ENSG00000137337	MDC1	0.191	1.20E-05
ENSG00000107036	RIC1	0.191	2.97E-04
ENSG00000113734	BNIP1	0.191	3.69E-02
ENSG00000164142	FAM160A1	0.191	6.47E-03
ENSG00000147133	TAF1	0.191	2.65E-04
ENSG00000127527	EPS15L1	0.191	4.90E-04
ENSG00000172493	AFF1	0.190	4.30E-05
ENSG00000162702	ZNF281	0.190	2.34E-04
ENSG00000019186	CYP24A1	0.190	1.60E-02
ENSG00000145715	RASA1	0.190	1.34E-04
ENSG00000178295	GEN1	0.190	8.75E-04
ENSG00000188566	NDOR1	0.190	1.82E-03
ENSG00000226419	SLC16A1-AS1	0.190	5.17E-03
ENSG00000106524	ANKMY2	0.190	3.32E-02

ENSG00000037749	MFAP3	0.190	5.41E-04
ENSG00000168175	MAPK1IP1L	0.189	1.02E-04
ENSG00000085644	ZNF213	0.189	1.63E-02
ENSG00000118007	STAG1	0.189	2.89E-04
ENSG00000053254	FOXN3	0.189	1.43E-04
ENSG00000066135	KDM4A	0.189	2.19E-04
ENSG00000117000	RLF	0.189	1.22E-04
ENSG00000115464	USP34	0.189	1.60E-05
ENSG00000047579	DTNBP1	0.189	1.92E-02
ENSG00000185716	C16orf52	0.188	2.46E-02
ENSG00000064393	HIPK2	0.188	1.17E-05
ENSG00000025293	PHF20	0.188	1.09E-05
ENSG00000117305	HMGCL	0.188	2.82E-02
ENSG00000242802	AP5Z1	0.188	7.85E-03
ENSG00000074590	NUAK1	0.188	6.39E-03
ENSG00000163882	POLR2H	0.188	2.87E-04
ENSG00000096968	JAK2	0.188	1.92E-02
ENSG00000119685	TTLL5	0.187	9.76E-05
ENSG00000087095	NLK	0.187	2.75E-03
ENSG00000103091	WDR59	0.187	2.25E-03
ENSG00000107829	FBXW4	0.187	9.16E-03
ENSG00000204256	BRD2	0.187	5.37E-07
ENSG00000137275	RIPK1	0.187	1.23E-04
ENSG00000101216	GMEB2	0.187	1.17E-04
ENSG00000120549	KIAA1217	0.187	1.09E-05
ENSG00000184867	ARMCX2	0.187	1.38E-03
ENSG00000134463	ECHDC3	0.187	1.60E-02
ENSG00000139531	SUOX	0.187	7.65E-03
ENSG00000166575	TMEM135	0.186	5.74E-03
ENSG00000164211	STARD4	0.186	2.52E-03
ENSG00000110756	HPS5	0.186	1.97E-03
ENSG00000109686	SH3D19	0.186	8.41E-05
ENSG00000235884	LINC00941	0.186	2.93E-03
ENSG00000003402	CFLAR	0.186	4.27E-05
ENSG00000173545	ZNF622	0.186	7.89E-04
ENSG00000110906	KCTD10	0.186	1.94E-05
ENSG00000185115	NDNL2	0.185	6.24E-03
ENSG00000197147	LRRC8B	0.185	3.04E-03
ENSG00000156973	PDE6D	0.185	1.42E-02
ENSG00000185950	IRS2	0.185	3.97E-04
ENSG00000162231	NXF1	0.185	2.94E-05
ENSG00000167766	ZNF83	0.185	5.74E-03
ENSG00000154319	FAM167A	0.185	4.08E-02

ENSG00000126883	NUP214	0.185	7.39E-06
ENSG00000123983	ACSL3	0.185	1.03E-05
ENSG00000184349	EFNA5	0.185	1.33E-03
ENSG00000131242	RAB11FIP4	0.185	4.77E-02
ENSG00000168209	DDIT4	0.185	2.71E-06
ENSG00000105011	ASF1B	0.185	1.56E-04
ENSG00000086015	MAST2	0.185	3.34E-04
ENSG00000198625	MDM4	0.185	6.63E-03
ENSG00000112110	MRPL18	0.184	1.15E-04
ENSG00000203995	ZYG11A	0.184	1.97E-02
ENSG00000117139	KDM5B	0.184	3.76E-05
ENSG00000129933	MAU2	0.184	1.45E-04
ENSG00000107862	GBF1	0.184	2.95E-05
ENSG00000104856	RELB	0.184	9.61E-03
ENSG00000102316	MAGED2	0.183	9.45E-04
ENSG00000179630	LACC1	0.183	7.43E-03
ENSG00000071794	HLTF	0.183	3.35E-04
ENSG00000151332	MBIP	0.183	2.07E-02
ENSG00000064655	EYA2	0.183	4.50E-05
ENSG00000170525	PFKFB3	0.183	1.11E-04
ENSG00000140443	IGF1R	0.183	5.46E-05
ENSG00000163374	YY1AP1	0.182	8.01E-05
ENSG00000153140	CETN3	0.182	1.02E-02
ENSG00000066084	DIP2B	0.182	9.03E-05
ENSG00000105607	GCDH	0.182	3.23E-02
ENSG00000182158	CREB3L2	0.182	4.80E-04
ENSG00000011405	PIK3C2A	0.182	1.06E-04
ENSG00000114982	KANSL3	0.182	1.98E-04
ENSG00000111880	RNGTT	0.181	2.05E-03
ENSG00000008083	JARID2	0.181	5.63E-05
ENSG00000137497	NUMA1	0.181	8.89E-06
ENSG00000171456	ASXL1	0.181	5.53E-06
ENSG00000163013	FBXO41	0.181	1.89E-02
ENSG00000028203	VEZT	0.181	1.12E-04
ENSG00000155729	KCTD18	0.181	1.29E-02
ENSG00000130940	CASZ1	0.181	2.40E-02
ENSG00000106459	NRF1	0.181	1.60E-02
ENSG00000198824	CHAMP1	0.181	1.68E-04
ENSG00000131196	NFATC1	0.181	2.33E-02
ENSG00000181894	ZNF329	0.180	3.98E-02
ENSG00000047932	GOPC	0.180	2.11E-05
ENSG00000127124	HIVEP3	0.180	3.21E-02
ENSG00000151779	NBAS	0.180	4.12E-03

ENSG00000137656	BUD13	0.180	1.40E-03
ENSG00000189266	PNRC2	0.180	2.93E-05
ENSG00000141084	RANBP10	0.180	7.22E-04
ENSG00000105612	DNASE2	0.180	2.51E-02
ENSG00000065328	MCM10	0.180	9.79E-05
ENSG00000181090	EHMT1	0.180	2.00E-04
ENSG00000110237	ARHGEF17	0.179	2.30E-03
ENSG00000146733	PSPH	0.179	8.30E-03
ENSG00000175854	SWI5	0.179	2.03E-02
ENSG00000119048	UBE2B	0.179	5.80E-04
ENSG00000198517	MAFK	0.179	1.18E-03
ENSG00000170881	RNF139	0.179	3.60E-03
ENSG00000114520	SNX4	0.179	6.11E-03
ENSG00000164180	TMEM161B	0.178	6.00E-03
ENSG00000196850	PPTC7	0.178	1.31E-04
ENSG00000198837	DENND4B	0.178	4.12E-03
ENSG00000160179	ABCG1	0.178	2.16E-02
ENSG00000227372	TP73-AS1	0.178	5.96E-03
ENSG00000051382	PIK3CB	0.178	2.17E-03
ENSG00000237298	TTN-AS1	0.178	3.52E-02
ENSG00000167987	VPS37C	0.178	7.69E-03
ENSG00000156931	VPS8	0.178	3.81E-02
ENSG00000100263	RHBDD3	0.178	3.51E-02
ENSG00000002822	MAD1L1	0.178	5.44E-03
ENSG00000174233	ADCY6	0.178	1.57E-03
ENSG00000168438	CDC40	0.177	4.00E-03
ENSG00000012822	CALCOCO1	0.177	3.69E-03
ENSG00000168818	STX18	0.177	1.24E-03
ENSG00000166881	NEMP1	0.177	4.61E-04
ENSG00000059758	CDK17	0.177	4.00E-04
ENSG00000160703	NLRX1	0.177	4.12E-02
ENSG00000143774	GUK1	0.177	8.49E-04
ENSG00000140463	BBS4	0.176	3.71E-02
ENSG00000150961	SEC24D	0.176	3.43E-03
ENSG00000151422	FER	0.176	4.00E-04
ENSG00000196367	TRRAP	0.176	4.60E-04
ENSG00000138778	CENPE	0.176	2.70E-04
ENSG00000166987	MBD6	0.176	1.01E-03
ENSG00000132740	IGHMBP2	0.176	1.06E-02
ENSG00000061936	SFSWAP	0.176	8.03E-05
ENSG00000048392	RRM2B	0.176	4.85E-03
ENSG00000135114	OASL	0.175	2.41E-03
ENSG00000197562	RAB40C	0.175	3.39E-02

ENSG00000103248	MTHFSD	0.175	1.41E-02
ENSG00000144228	SPOPL	0.175	1.45E-02
ENSG00000213995	CARKD	0.175	6.42E-03
ENSG00000119004	CYP20A1	0.175	1.07E-02
ENSG00000153815	CMIP	0.175	1.34E-04
ENSG00000157191	NECAP2	0.175	2.87E-04
ENSG00000105705	SUGP1	0.175	8.48E-04
ENSG00000010803	SCMH1	0.175	8.38E-04
ENSG00000075089	ACTR6	0.174	3.13E-02
ENSG00000164168	TMEM184C	0.174	4.08E-04
ENSG00000198874	TYW1	0.174	3.07E-03
ENSG00000144645	OSBPL10	0.174	6.50E-04
ENSG00000131697	NPHP4	0.174	2.18E-02
ENSG00000225190	PLEKHM1	0.174	3.65E-03
ENSG00000196417	ZNF765	0.174	4.94E-02
ENSG00000129003	VPS13C	0.174	6.63E-03
ENSG00000163539	CLASP2	0.174	1.17E-03
ENSG00000204217	BMPR2	0.174	5.74E-04
ENSG00000169871	TRIM56	0.173	5.82E-05
ENSG00000168994	PXDC1	0.173	3.58E-03
ENSG00000066455	GOLGA5	0.173	7.42E-04
ENSG00000120727	PAIP2	0.173	1.24E-03
ENSG00000137166	FOXP4	0.173	4.14E-03
ENSG00000164031	DNAJB14	0.173	1.40E-02
ENSG00000082213	C5orf22	0.173	7.81E-04
ENSG00000076382	SPAG5	0.173	4.50E-04
ENSG00000100324	TAB1	0.173	5.72E-03
ENSG00000185684	EP400NL	0.173	1.32E-02
ENSG00000082805	ERC1	0.172	3.92E-05
ENSG00000014138	POLA2	0.172	1.64E-03
ENSG00000137574	TGS1	0.172	1.42E-03
ENSG00000171621	SPSB1	0.172	6.84E-03
ENSG00000138036	DYNC2LI1	0.172	4.71E-02
ENSG00000135457	TFCP2	0.171	5.13E-04
ENSG00000132964	CDK8	0.171	3.06E-03
ENSG00000149577	SIDT2	0.171	1.40E-02
ENSG00000067208	EVI5	0.171	1.07E-02
ENSG00000151461	UPF2	0.171	2.14E-04
ENSG00000080189	SLC35C2	0.171	4.44E-04
ENSG00000176148	TCP11L1	0.171	1.18E-02
ENSG00000117724	CENPF	0.170	1.26E-05
ENSG00000171497	PPID	0.170	8.97E-04
ENSG00000147130	ZMYM3	0.170	2.32E-03

ENSG00000114268	PFKFB4	0.170	4.88E-02
ENSG00000157693	C9orf91	0.170	1.96E-02
ENSG00000119986	AVPI1	0.170	7.34E-04
ENSG00000168591	TMUB2	0.170	3.66E-03
ENSG00000157349	DDX19B	0.170	1.88E-02
ENSG00000170315	UBB	0.170	1.69E-04
ENSG00000243477	NAT6	0.170	3.78E-02
ENSG00000100056	DGCR14	0.169	1.78E-02
ENSG00000234456	MAGI2-AS3	0.169	7.36E-03
ENSG00000139350	NEDD1	0.169	2.27E-03
ENSG00000005812	FBXL3	0.169	2.31E-03
ENSG00000137992	DBT	0.169	5.22E-03
ENSG00000070476	ZXDC	0.169	1.16E-02
ENSG00000141646	SMAD4	0.169	1.00E-03
ENSG00000213186	TRIM59	0.169	4.08E-02
ENSG00000119522	DENND1A	0.169	6.09E-03
ENSG00000067955	CBFB	0.169	9.72E-04
ENSG00000123080	CDKN2C	0.168	3.29E-02
ENSG00000122484	RPAP2	0.168	1.12E-02
ENSG00000136492	BRIP1	0.168	4.89E-04
ENSG00000141441	GAREM	0.168	5.41E-03
ENSG00000085224	ATRX	0.168	1.20E-04
ENSG00000078142	PIK3C3	0.168	2.43E-03
ENSG00000023608	SNAPC1	0.167	2.27E-02
ENSG00000171466	ZNF562	0.167	1.27E-03
ENSG00000133131	MORC4	0.167	7.27E-03
ENSG00000132109	TRIM21	0.166	2.19E-02
ENSG00000152894	PTPRK	0.166	3.11E-03
ENSG00000137812	CASC5	0.166	1.92E-04
ENSG00000108509	CAMTA2	0.166	8.63E-04
ENSG00000144381	HSPD1	0.166	6.65E-05
ENSG00000170471	RALGAPB	0.166	1.74E-05
ENSG00000157224	CLDN12	0.166	1.03E-02
ENSG00000156381	ANKRD9	0.166	4.87E-02
ENSG00000156873	PHKG2	0.166	1.50E-02
ENSG00000135269	TES	0.166	5.71E-04
ENSG00000087338	GMCL1	0.165	1.31E-02
ENSG00000044459	CNTLN	0.165	1.39E-02
ENSG00000005020	SKAP2	0.165	3.17E-02
ENSG00000197724	PHF2	0.165	2.52E-03
ENSG00000179119	SPTY2D1	0.165	5.73E-04
ENSG00000121310	ECHDC2	0.164	2.56E-02
ENSG00000049246	PER3	0.164	5.61E-03

ENSG00000159259	CHAF1B	0.164	3.45E-03
ENSG00000138398	PPIG	0.164	2.78E-04
ENSG00000249348	UGDH-AS1	0.164	4.89E-02
ENSG00000237441	RGL2	0.164	1.92E-03
ENSG00000172731	LRRC20	0.164	3.15E-02
ENSG00000147316	MCPH1	0.164	8.91E-04
ENSG00000132613	MTSS1L	0.164	6.22E-04
ENSG00000119041	GTF3C3	0.164	2.47E-03
ENSG00000127580	WDR24	0.164	1.82E-02
ENSG00000008853	RHOBTB2	0.163	3.23E-04
ENSG00000121060	TRIM25	0.163	1.83E-04
ENSG00000112419	PHACTR2	0.163	1.73E-03
ENSG00000142459	EVI5L	0.163	1.04E-02
ENSG00000156671	SAMD8	0.162	7.02E-04
ENSG00000163781	TOPBP1	0.162	2.89E-04
ENSG00000162298	SYVN1	0.162	1.79E-03
ENSG00000102974	CTCF	0.162	2.32E-04
ENSG00000146950	SHROOM2	0.162	1.31E-02
ENSG00000130479	MAP1S	0.162	5.97E-03
ENSG00000136111	TBC1D4	0.161	2.70E-03
ENSG00000139651	ZNF740	0.161	5.21E-03
ENSG00000120162	MOB3B	0.161	7.69E-03
ENSG00000146830	GIGYF1	0.161	2.46E-03
ENSG00000152942	RAD17	0.161	6.21E-04
ENSG00000137764	MAP2K5	0.161	2.03E-02
ENSG00000163945	UVSSA	0.161	4.67E-02
ENSG00000071051	NCK2	0.161	1.25E-02
ENSG00000184661	CDCA2	0.161	1.91E-03
ENSG00000035928	RFC1	0.161	1.33E-04
ENSG00000117597	DIEXF	0.160	8.81E-04
ENSG00000171634	BPTF	0.160	2.87E-05
ENSG00000197121	PGAP1	0.160	2.86E-02
ENSG00000139620	KANSL2	0.160	7.48E-03
ENSG00000127870	RNF6	0.160	1.46E-04
ENSG00000107625	DDX50	0.160	1.88E-03
ENSG00000196453	ZNF777	0.160	7.80E-03
ENSG00000051009	FAM160A2	0.159	1.59E-02
ENSG00000126070	AGO3	0.159	9.34E-03
ENSG00000176915	ANKLE2	0.159	3.41E-05
ENSG00000119950	MXI1	0.159	1.35E-02
ENSG00000109445	ZNF330	0.159	2.80E-03
ENSG00000107104	KANK1	0.159	2.08E-04
ENSG00000185989	RASA3	0.159	8.91E-03

ENSG00000129484	PARP2	0.158	1.86E-03
ENSG00000139116	KIF21A	0.158	1.73E-03
ENSG00000134686	PHC2	0.158	1.49E-04
ENSG00000159111	MRPL10	0.158	4.29E-04
ENSG00000181938	GINS3	0.158	8.56E-03
ENSG00000198876	DCAF12	0.158	3.03E-04
ENSG00000115687	PASK	0.158	2.48E-02
ENSG00000254004	ZNF260	0.158	9.72E-03
ENSG00000064933	PMS1	0.157	8.99E-03
ENSG00000142655	PEX14	0.157	5.16E-03
ENSG00000187954	CYHR1	0.157	4.05E-02
ENSG00000104517	UBR5	0.157	5.43E-05
ENSG00000169908	TM4SF1	0.157	7.82E-03
ENSG00000169398	PTK2	0.157	1.43E-04
ENSG00000001629	ANKIB1	0.157	5.48E-04
ENSG00000144711	IQSEC1	0.157	1.99E-02
ENSG00000124782	RREB1	0.156	9.94E-04
ENSG00000114857	NKTR	0.156	8.81E-04
ENSG00000182923	CEP63	0.156	9.81E-03
ENSG00000106299	WASL	0.156	4.93E-03
ENSG00000163820	FYCO1	0.156	3.19E-03
ENSG00000164506	STXBP5	0.156	8.30E-03
ENSG00000204054	LINC00963	0.156	2.54E-03
ENSG00000168395	ING5	0.156	2.62E-02
ENSG00000169504	CLIC4	0.156	8.39E-04
ENSG00000153879	CEBPG	0.156	1.95E-03
ENSG00000007341	ST7L	0.155	4.73E-02
ENSG00000156453	PCDH1	0.155	1.87E-03
ENSG00000005700	IBTK	0.155	1.96E-03
ENSG00000017797	RALBP1	0.155	1.24E-04
ENSG00000167291	TBC1D16	0.155	2.77E-03
ENSG00000172954	LCLAT1	0.154	4.93E-03
ENSG00000112245	PTP4A1	0.154	7.97E-04
ENSG00000137575	SDCBP	0.154	7.43E-04
ENSG00000163960	UBXN7	0.154	3.60E-04
ENSG00000131507	NDFIP1	0.154	1.46E-04
ENSG00000088298	EDEM2	0.153	4.28E-02
ENSG00000171492	LRRC8D	0.153	1.33E-02
ENSG00000166123	GPT2	0.153	2.87E-03
ENSG00000117475	BLZF1	0.153	6.51E-03
ENSG00000119844	AFTPH	0.153	6.39E-03
ENSG00000168434	COG7	0.153	3.50E-02
ENSG00000008441	NFIX	0.153	5.05E-03

ENSG00000103994	ZNF106	0.153	1.07E-04
ENSG00000120137	PANK3	0.153	9.24E-04
ENSG00000136144	RCBTB1	0.153	1.98E-02
ENSG00000089289	IGBP1	0.153	1.43E-02
ENSG00000116678	LEPR	0.153	2.18E-02
ENSG00000099260	PALMD	0.152	4.65E-02
ENSG00000181027	FKRP	0.152	3.43E-02
ENSG00000168610	STAT3	0.152	8.84E-05
ENSG00000197976	AKAP17A	0.152	1.00E-03
ENSG00000198563	DDX39B	0.152	6.07E-03
ENSG00000102189	EEA1	0.152	1.97E-03
ENSG00000110583	NAA40	0.152	9.63E-03
ENSG00000197381	ADARB1	0.152	5.49E-03
ENSG00000196428	TSC22D2	0.152	3.62E-03
ENSG00000086570	FAT2	0.152	6.04E-04
ENSG00000104299	INTS9	0.152	1.14E-02
ENSG00000185219	ZNF445	0.151	1.85E-02
ENSG00000100207	TCF20	0.151	1.83E-04
ENSG00000068724	TTC7A	0.151	7.45E-03
ENSG00000061987	MON2	0.151	1.03E-02
ENSG00000175984	DENND2C	0.151	3.66E-02
ENSG00000051180	RAD51	0.151	1.60E-02
ENSG00000145284	SCD5	0.151	3.13E-02
ENSG00000136002	ARHGEF4	0.151	9.93E-03
ENSG00000171148	TADA3	0.151	1.87E-03
ENSG00000075407	ZNF37A	0.150	2.43E-03
ENSG00000134569	LRP4	0.150	3.56E-02
ENSG00000196693	ZNF33B	0.150	1.54E-02
ENSG00000145431	PDGFC	0.150	6.04E-03
ENSG00000149679	CABLES2	0.150	3.47E-02
ENSG00000142961	MOB3C	0.150	2.82E-02
ENSG00000164494	PDSS2	0.150	1.75E-02
ENSG00000109062	SLC9A3R1	0.150	6.18E-03
ENSG00000172262	ZNF131	0.149	9.21E-04
ENSG00000174953	DHX36	0.149	4.60E-03
ENSG00000110911	SLC11A2	0.149	9.82E-03
ENSG00000065243	PKN2	0.149	5.81E-03
ENSG00000130703	OSBPL2	0.148	3.51E-03
ENSG00000155329	ZCCHC10	0.148	6.16E-03
ENSG00000109320	NFKB1	0.148	9.97E-05
ENSG00000140992	PDPK1	0.148	3.58E-03
ENSG00000244754	N4BP2L2	0.148	8.79E-03
ENSG00000146376	ARHGAP18	0.147	1.59E-02

ENSG00000163946	FAM208A	0.147	2.87E-04
ENSG00000161642	ZNF385A	0.147	2.22E-03
ENSG00000125686	MED1	0.147	1.33E-04
ENSG00000160293	VAV2	0.147	8.19E-04
ENSG00000129534	MIS18BP1	0.147	9.49E-03
ENSG00000100038	TOP3B	0.147	4.85E-02
ENSG00000120688	WBP4	0.146	1.37E-02
ENSG00000005801	ZNF195	0.146	4.50E-02
ENSG00000056586	RC3H2	0.146	4.47E-04
ENSG00000153339	TRAPPC8	0.146	3.05E-03
ENSG00000033170	FUT8	0.146	3.98E-02
ENSG00000101190	TCFL5	0.146	1.34E-02
ENSG00000160299	PCNT	0.146	2.88E-03
ENSG00000062598	ELMO2	0.146	3.24E-03
ENSG00000138081	FBXO11	0.146	1.18E-03
ENSG00000133606	MKRN1	0.146	4.54E-03
ENSG00000162419	GMEB1	0.146	1.30E-02
ENSG00000141905	NFIC	0.146	4.60E-03
ENSG00000072778	ACADVL	0.145	4.41E-04
ENSG00000054654	SYNE2	0.145	1.47E-03
ENSG00000120656	TAF12	0.145	3.89E-03
ENSG00000168264	IRF2BP2	0.145	1.48E-04
ENSG00000042088	TDP1	0.145	2.52E-02
ENSG00000124486	USP9X	0.145	6.00E-04
ENSG00000114770	ABCC5	0.145	4.90E-03
ENSG00000112701	SENP6	0.144	4.30E-03
ENSG00000013561	RNF14	0.144	7.39E-03
ENSG00000101181	MTG2	0.144	8.62E-04
ENSG00000160551	TAOK1	0.143	3.26E-04
ENSG00000172765	TMCC1	0.143	7.92E-03
ENSG00000157181	C1orf27	0.143	4.05E-03
ENSG00000154760	SLFN13	0.143	1.36E-03
ENSG00000106462	EZH2	0.143	1.34E-03
ENSG00000131725	WDR44	0.143	1.68E-02
ENSG00000065911	MTHFD2	0.143	6.58E-04
ENSG00000138182	KIF20B	0.143	1.15E-03
ENSG00000164068	RNF123	0.143	1.45E-02
ENSG00000067596	DHX8	0.143	2.34E-03
ENSG00000137413	TAF8	0.142	2.18E-02
ENSG00000109689	STIM2	0.142	2.69E-03
ENSG00000137513	NARS2	0.142	4.25E-02
ENSG00000119139	TJP2	0.142	1.33E-03
ENSG00000167315	ACAA2	0.142	2.93E-02

ENSG00000154814	OXNAD1	0.142	4.02E-02
ENSG00000163535	SGOL2	0.142	1.50E-02
ENSG00000152242	C18orf25	0.142	1.19E-02
ENSG00000135597	REPS1	0.141	4.22E-03
ENSG00000179361	ARID3B	0.141	1.29E-02
ENSG00000072786	STK10	0.141	2.00E-03
ENSG00000073417	PDE8A	0.141	5.24E-03
ENSG00000115267	IFIH1	0.141	2.31E-02
ENSG00000106144	CASP2	0.141	1.43E-03
ENSG00000156802	ATAD2	0.140	1.24E-03
ENSG00000111247	RAD51AP1	0.140	2.55E-02
ENSG00000154144	TBRG1	0.140	7.08E-03
ENSG00000136436	CALCOCO2	0.139	2.48E-03
ENSG00000253738	OTUD6B-AS1	0.139	1.03E-02
ENSG00000109323	MANBA	0.139	2.41E-02
ENSG00000118495	PLAGL1	0.139	2.65E-02
ENSG00000179604	CDC42EP4	0.139	5.69E-03
ENSG00000072864	NDE1	0.139	2.22E-03
ENSG00000146143	PRIM2	0.139	2.99E-02
ENSG00000166887	VPS39	0.139	2.41E-03
ENSG00000179151	EDC3	0.139	3.35E-03
ENSG00000167110	GOLGA2	0.138	1.31E-03
ENSG00000156052	GNAQ	0.138	6.74E-03
ENSG00000112249	ASCC3	0.138	3.35E-04
ENSG00000170903	MSANTD4	0.138	3.45E-02
ENSG00000185800	DMWD	0.138	2.45E-02
ENSG00000177917	ARL6IP6	0.138	4.48E-02
ENSG00000106105	GARS	0.137	3.23E-04
ENSG00000141458	NPC1	0.137	2.21E-04
ENSG00000128908	INO80	0.137	3.12E-03
ENSG00000136108	CKAP2	0.137	1.55E-03
ENSG00000131408	NR1H2	0.137	3.12E-02
ENSG00000145687	SSBP2	0.137	2.07E-02
ENSG00000198369	SPRED2	0.136	1.03E-03
ENSG00000080503	SMARCA2	0.136	2.87E-03
ENSG00000140718	FTO	0.136	1.01E-02
ENSG00000132256	TRIM5	0.136	2.50E-02
ENSG00000168488	ATXN2L	0.136	2.31E-03
ENSG00000136854	STXBP1	0.136	4.23E-03
ENSG00000050426	LETMD1	0.136	2.06E-02
ENSG00000138614	VWA9	0.135	9.71E-03
ENSG00000278311	GGNBP2	0.135	1.00E-03
ENSG00000225151	GOLGA2P7	0.134	1.59E-02

ENSG00000120159	CAAP1	0.134	1.94E-02
ENSG00000144659	SLC25A38	0.134	1.14E-02
ENSG00000074319	TSG101	0.134	1.88E-03
ENSG00000132669	RIN2	0.133	4.07E-03
ENSG00000264522	OTUD7B	0.133	3.85E-03
ENSG00000115935	WIPF1	0.133	5.65E-03
ENSG00000079313	REXO1	0.133	1.35E-02
ENSG00000189180	ZNF33A	0.133	1.27E-02
ENSG00000130779	CLIP1	0.132	9.72E-04
ENSG00000156970	BUB1B	0.132	2.03E-03
ENSG00000173210	ABLIM3	0.132	1.07E-02
ENSG00000166801	FAM111A	0.132	2.91E-03
ENSG00000160305	DIP2A	0.132	1.36E-02
ENSG00000131711	MAP1B	0.132	2.83E-03
ENSG00000077152	UBE2T	0.132	1.53E-02
ENSG00000198642	KLHL9	0.132	3.45E-02
ENSG00000204536	CCHCR1	0.132	2.03E-02
ENSG00000115942	ORC2	0.131	1.87E-02
ENSG00000072364	AFF4	0.131	1.84E-04
ENSG00000163840	DTX3L	0.131	7.17E-03
ENSG00000138271	GPR87	0.131	9.77E-03
ENSG00000114439	BBX	0.131	5.28E-04
ENSG00000163104	SMARCAD1	0.131	4.12E-03
ENSG00000141867	BRD4	0.131	2.75E-03
ENSG00000138246	DNAJC13	0.130	2.51E-03
ENSG00000178691	SUZ12	0.130	5.43E-03
ENSG00000178105	DDX10	0.130	1.26E-02
ENSG00000066136	NFYC	0.130	1.82E-02
ENSG00000163507	KIAA1524	0.130	2.64E-02
ENSG00000102786	INTS6	0.129	3.35E-03
ENSG00000126464	PRR12	0.129	1.77E-02
ENSG00000118454	ANKRD13C	0.129	9.71E-03
ENSG00000048991	R3HDM1	0.129	1.73E-03
ENSG00000140332	TLE3	0.129	1.21E-02
ENSG00000008710	PKD1	0.129	2.67E-02
ENSG00000154305	MIA3	0.128	1.90E-03
ENSG00000114573	ATP6V1A	0.128	7.08E-03
ENSG00000070610	GBA2	0.128	2.01E-02
ENSG00000152818	UTRN	0.128	6.49E-03
ENSG00000172466	ZNF24	0.128	3.46E-03
ENSG00000137073	UBAP2	0.128	7.37E-04
ENSG00000105771	SMG9	0.127	6.33E-03
ENSG00000119760	SUPT7L	0.127	6.19E-03

ENSG00000134684	YARS	0.127	1.05E-03
ENSG00000163125	RPRD2	0.127	3.41E-03
ENSG00000120451	SNX19	0.127	3.34E-03
ENSG00000131013	PPIL4	0.127	3.15E-02
ENSG00000074266	EED	0.127	5.06E-02
ENSG00000197969	VPS13A	0.127	1.08E-02
ENSG00000141198	TOM1L1	0.127	1.44E-02
ENSG00000075568	TMEM131	0.127	1.95E-03
ENSG00000054965	FAM168A	0.127	9.04E-03
ENSG00000101596	SMCHD1	0.126	9.53E-03
ENSG00000084112	SSH1	0.126	7.36E-04
ENSG00000170004	CHD3	0.126	5.77E-04
ENSG00000106211	HSPB1	0.126	2.74E-02
ENSG00000186918	ZNF395	0.126	2.72E-02
ENSG00000146670	CDCA5	0.126	1.00E-03
ENSG00000117758	STX12	0.126	3.81E-02
ENSG00000134775	FHOD3	0.126	6.82E-03
ENSG00000180917	CMTR2	0.126	3.61E-02
ENSG00000214022	REPIN1	0.126	2.92E-02
ENSG00000196954	CASP4	0.125	1.08E-02
ENSG00000076356	PLXNA2	0.125	4.87E-03
ENSG00000090861	AARS	0.125	2.81E-03
ENSG00000169499	PLEKHA2	0.125	2.23E-02
ENSG00000102763	VWA8	0.125	1.57E-02
ENSG00000163348	PYGO2	0.125	2.21E-02
ENSG00000188313	PLSCR1	0.125	2.31E-02
ENSG00000169607	CKAP2L	0.125	3.19E-03
ENSG00000162623	TYW3	0.125	2.35E-02
ENSG00000156304	SCAF4	0.125	3.32E-03
ENSG00000196670	ZFP62	0.124	4.65E-02
ENSG00000145349	CAMK2D	0.124	1.89E-02
ENSG00000173482	PTPRM	0.124	2.46E-03
ENSG00000102780	DGKH	0.124	9.77E-03
ENSG00000167548	KMT2D	0.124	3.32E-02
ENSG00000121289	CEP89	0.124	1.42E-02
ENSG00000182378	PLCXD1	0.124	4.98E-02
ENSG00000135945	REV1	0.123	2.71E-02
ENSG00000198690	FAN1	0.123	2.87E-02
ENSG00000154370	TRIM11	0.123	1.86E-02
ENSG00000175592	FOSL1	0.123	1.84E-03
ENSG00000139505	MTMR6	0.123	1.07E-02
ENSG00000115109	EPB41L5	0.123	4.76E-02
ENSG00000185728	YTHDF3	0.122	3.39E-03

ENSG00000070761	CFAP20	0.122	1.87E-02
ENSG00000152127	MGAT5	0.122	1.31E-02
ENSG00000159314	ARHGAP27	0.122	4.28E-02
ENSG00000105298	CACTIN	0.122	2.40E-02
ENSG00000198000	NOL8	0.122	3.12E-02
ENSG00000077254	USP33	0.122	3.25E-02
ENSG00000138780	GSTCD	0.121	2.16E-02
ENSG00000112130	RNF8	0.121	4.40E-02
ENSG00000076242	MLH1	0.121	7.84E-03
ENSG00000168439	STIP1	0.121	5.65E-04
ENSG00000148700	ADD3	0.120	4.43E-02
ENSG00000129595	EPB41L4A	0.120	3.80E-02
ENSG00000185619	PCGF3	0.120	6.21E-03
ENSG00000148498	PARD3	0.120	5.61E-03
ENSG00000143382	ADAMTSL4	0.120	1.84E-02
ENSG00000157538	DSCR3	0.120	1.01E-02
ENSG00000133216	EPHB2	0.120	3.10E-02
ENSG00000110713	NUP98	0.120	6.48E-04
ENSG00000158161	EYA3	0.119	1.24E-02
ENSG00000111012	CYP27B1	0.119	3.73E-02
ENSG00000072803	FBXW11	0.119	4.08E-03
ENSG00000148660	CAMK2G	0.119	3.51E-02
ENSG00000151849	CENPJ	0.119	1.34E-02
ENSG00000186185	KIF18B	0.118	2.42E-02
ENSG00000132017	DCAF15	0.118	4.26E-02
ENSG00000102858	MGRN1	0.118	3.55E-02
ENSG00000151292	CSNK1G3	0.118	3.41E-02
ENSG00000073050	XRCC1	0.117	3.00E-02
ENSG00000157514	TSC22D3	0.117	1.20E-02
ENSG00000198218	QRICH1	0.117	2.13E-03
ENSG00000153561	RMND5A	0.117	1.52E-02
ENSG00000149532	CPSF7	0.117	1.29E-03
ENSG00000198604	BAZ1A	0.116	3.67E-03
ENSG00000159023	EPB41	0.116	4.07E-02
ENSG00000126653	NSRP1	0.116	1.49E-02
ENSG00000147459	DOCK5	0.116	3.54E-03
ENSG00000110330	BIRC2	0.116	1.39E-02
ENSG00000102870	ZNF629	0.116	2.16E-02
ENSG00000198961	PJA2	0.116	1.31E-02
ENSG00000236287	ZBED5	0.115	2.21E-02
ENSG00000163950	SLBP	0.115	6.48E-03
ENSG00000122417	ODF2L	0.115	4.63E-02
ENSG00000278259	MYO19	0.115	1.95E-03

ENSG00000165660	FAM175B	0.115	2.27E-02
ENSG00000087206	UIMC1	0.115	2.88E-02
ENSG00000206560	ANKRD28	0.115	1.60E-02
ENSG00000068323	TFE3	0.115	1.93E-02
ENSG00000096384	HSP90AB1	0.114	2.46E-04
ENSG00000205726	ITSN1	0.114	7.18E-03
ENSG00000163214	DHX57	0.114	2.90E-02
ENSG00000157540	DYRK1A	0.114	1.73E-02
ENSG00000134690	CDCA8	0.114	2.67E-02
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ENSG00000137817	PARP6	0.113	4.21E-02
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ENSG00000161021	MAML1	0.113	9.72E-03
ENSG00000038532	CLEC16A	0.112	2.32E-02
ENSG00000101407	TTI1	0.112	8.84E-03
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ENSG00000138802	SEC24B	0.112	2.65E-02
ENSG00000113328	CCNG1	0.111	1.93E-02
ENSG00000197579	TOPORS	0.111	8.42E-03
ENSG00000054523	KIF1B	0.111	4.29E-03
ENSG00000113407	TARS	0.111	2.37E-03
ENSG00000110048	OSBP	0.110	1.87E-03
ENSG00000117713	ARID1A	0.110	1.06E-02
ENSG00000132912	DCTN4	0.110	1.62E-02
ENSG00000171992	SYNPO	0.110	1.38E-02
ENSG00000125107	CNOT1	0.110	8.38E-04
ENSG00000106346	USP42	0.110	3.59E-02
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ENSG00000101782	RIOK3	0.109	8.67E-03
ENSG00000154124	OTULIN	0.109	1.95E-02
ENSG00000143970	ASXL2	0.109	6.84E-03
ENSG00000088038	CNOT3	0.109	8.65E-03
ENSG00000169180	XPO6	0.108	1.92E-03
ENSG00000095564	BTAF1	0.108	2.92E-02
ENSG00000170242	USP47	0.108	1.02E-02
ENSG00000184584	TMEM173	0.108	4.36E-02
ENSG00000010322	NISCH	0.108	4.60E-02
ENSG00000145216	FIP1L1	0.108	7.39E-03
ENSG00000184014	DENND5A	0.107	1.88E-02

ENSG00000058063	ATP11B	0.107	2.89E-02
ENSG00000143079	CTTNBP2NL	0.107	1.81E-02
ENSG00000131043	AAR2	0.107	1.91E-02
ENSG00000162337	LRP5	0.107	4.31E-02
ENSG00000152795	HNRNPDL	0.106	2.48E-03
ENSG00000125266	EFNB2	0.106	1.06E-02
ENSG00000141027	NCOR1	0.106	2.61E-03
ENSG00000099917	MED15	0.106	2.26E-02
ENSG00000106070	GRB10	0.106	4.92E-02
ENSG00000113318	MSH3	0.106	4.68E-02
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ENSG00000101126	ADNP	0.105	8.21E-03
ENSG00000066777	ARFGEF1	0.105	2.13E-02
ENSG00000004478	FKBP4	0.104	4.56E-03
ENSG00000111596	CNOT2	0.104	1.08E-02
ENSG00000255112	CHMP1B	0.104	2.33E-02
ENSG00000145817	YIPF5	0.104	1.03E-02
ENSG00000108091	CCDC6	0.104	2.62E-02
ENSG00000175215	CTDSP2	0.103	9.67E-03
ENSG00000142039	CCDC97	0.103	3.71E-02
ENSG00000133773	CCDC59	0.103	4.75E-02
ENSG00000168256	NKIRAS2	0.103	2.20E-02
ENSG00000183495	EP400	0.103	1.88E-02
ENSG00000171862	PTEN	0.103	2.77E-02
ENSG00000183354	KIAA2026	0.103	4.33E-02
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ENSG00000076003	MCM6	0.102	2.30E-02
ENSG00000076067	RBMS2	0.101	3.73E-02
ENSG00000168214	RBPJ	0.101	1.74E-02
ENSG00000133193	FAM104A	0.101	3.22E-02
ENSG00000170037	CNTROB	0.101	3.61E-02
ENSG00000116977	LGALS8	0.101	2.44E-02
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ENSG00000100109	TFIP11	0.101	4.07E-02
ENSG00000120685	PROSER1	0.100	1.78E-02
ENSG00000134109	EDEM1	0.100	3.00E-02
ENSG00000136021	SCYL2	0.100	5.05E-02
ENSG00000102606	ARHGEF7	0.100	2.03E-02
ENSG00000157837	SPPL3	0.100	4.94E-02
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ENSG00000102921	N4BP1	0.098	2.32E-02

ENSG00000169188	APEX2	0.098	4.36E-02
ENSG00000006831	ADIPOR2	0.098	7.69E-03
ENSG00000124198	ARFGEF2	0.098	6.75E-03
ENSG00000111676	ATN1	0.098	1.78E-02
ENSG00000075151	EIF4G3	0.098	5.99E-03
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ENSG00000101752	MIB1	0.097	1.86E-02
ENSG00000101109	STK4	0.097	1.91E-02
ENSG00000149639	SOGA1	0.097	1.80E-02
ENSG00000184445	KNTC1	0.097	3.38E-02
ENSG00000113360	DROSHA	0.097	5.46E-03
ENSG00000175224	ATG13	0.096	2.64E-02
ENSG00000139496	NUP58	0.096	1.60E-02
ENSG00000165304	MELK	0.096	9.72E-03
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ENSG00000116754	SRSF11	0.094	1.03E-02
ENSG00000135919	SERPINE2	0.093	4.50E-02
ENSG00000092470	WDR76	0.093	2.96E-02
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ENSG00000182149	IST1	0.093	2.82E-02
ENSG00000105281	SLC1A5	0.092	8.48E-03
ENSG00000142945	KIF2C	0.092	2.04E-02
ENSG00000253352	TUG1	0.092	1.96E-02
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ENSG00000141644	MBD1	0.091	2.28E-02
ENSG00000101457	DNTTIP1	0.091	5.04E-02
ENSG00000138771	SHROOM3	0.091	3.22E-02
ENSG00000179134	SAMD4B	0.090	1.51E-02
ENSG00000074356	NCBP3	0.090	5.01E-02
ENSG00000099331	MYO9B	0.090	3.61E-02
ENSG00000144674	GOLGA4	0.090	2.97E-02
ENSG00000105835	NAMPT	0.090	3.71E-02
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ENSG00000186591	UBE2H	0.090	1.62E-02
ENSG00000125538	IL1B	0.089	4.22E-02
ENSG00000100664	EIF5	0.089	1.02E-02
ENSG00000144824	PHLDB2	0.088	3.46E-02
ENSG00000131626	PPFIA1	0.088	4.52E-02
ENSG00000101773	RBBP8	0.088	1.32E-02
ENSG00000066923	STAG3	0.088	2.18E-02
ENSG00000171475	WIPF2	0.088	5.04E-02

ENSG00000104067	TJP1	0.087	1.12E-02
ENSG00000099940	SNAP29	0.087	4.69E-02
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ENSG00000133872	SARAF	0.087	3.03E-02
ENSG00000023516	AKAP11	0.086	4.42E-02
ENSG00000197622	CDC42SE1	0.086	1.16E-02
ENSG00000100441	KHNYN	0.085	3.59E-02
ENSG00000139514	SLC7A1	0.085	1.57E-02
ENSG00000140259	MFAP1	0.084	4.23E-02
ENSG00000136861	CDK5RAP2	0.083	2.89E-02
ENSG00000073282	TP63	0.083	1.95E-02
ENSG00000083444	PLOD1	0.082	3.26E-02
ENSG00000143624	INTS3	0.081	4.96E-02
ENSG00000086758	HUWE1	0.080	4.73E-02
ENSG00000138160	KIF11	0.078	4.49E-02
ENSG00000173812	EIF1	0.078	2.34E-02
ENSG00000145555	MYO10	0.078	1.99E-02
ENSG00000148396	SEC16A	0.078	3.50E-02
ENSG00000184292	TACSTD2	0.077	3.04E-02
ENSG00000176994	SMCR8	0.077	4.89E-02
ENSG00000092203	TOX4	0.076	4.64E-02
ENSG00000073111	MCM2	0.075	5.01E-02
ENSG00000080603	SRCAP	0.075	4.62E-02
ENSG00000010818	HIVEP2	0.072	4.28E-02
ENSG00000077235	GTF3C1	0.071	5.06E-02
ENSG00000031698	SARS	0.070	3.27E-02
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ENSG00000182446	NPLOC4	-0.070	4.27E-02
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ENSG00000115484	CCT4	-0.072	3.57E-02
ENSG00000171824	EXOSC10	-0.072	4.07E-02
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ENSG00000117394	SLC2A1	-0.073	3.57E-02
ENSG00000204574	ABCF1	-0.073	4.27E-02
ENSG00000110367	DDX6	-0.074	3.54E-02

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ENSG00000166250	CLMP	-0.077	2.56E-02
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ENSG00000198763	MT-ND2	-0.079	2.25E-02
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ENSG00000198663	C6orf89	-0.080	2.70E-02
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ENSG00000161057	PSMC2	-0.090	1.77E-02
ENSG00000117298	ECE1	-0.090	3.08E-02
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ENSG00000114650	SCAP	-0.092	4.85E-02
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ENSG00000061676	NCKAP1	-0.093	2.75E-02
ENSG00000117505	DR1	-0.093	2.07E-02
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ENSG00000140105	WARS	-0.094	7.96E-03
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ENSG00000197858	GPAA1	-0.095	2.82E-02
ENSG00000135506	OS9	-0.095	8.74E-03
ENSG00000159176	CSRP1	-0.095	1.63E-02
ENSG00000141002	TCF25	-0.095	2.46E-02

ENSG00000100280	AP1B1	-0.096	3.22E-02
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ENSG00000148248	SURF4	-0.097	4.13E-03
ENSG00000204227	RING1	-0.097	4.97E-02
ENSG00000134453	RBM17	-0.097	1.40E-02
ENSG00000143641	GALNT2	-0.097	1.47E-02
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ENSG00000111799	COL12A1	-0.097	1.55E-02
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ENSG00000120802	TMPO	-0.099	1.61E-02
ENSG00000148426	PROSER2	-0.099	2.76E-02
ENSG00000135720	DYNC1LI2	-0.100	7.08E-03
ENSG00000043143	JADE2	-0.100	9.63E-03
ENSG00000104904	OAZ1	-0.100	4.48E-02
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ENSG00000150768	DLAT	-0.100	3.47E-02
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ENSG00000100403	ZC3H7B	-0.105	1.12E-02
ENSG00000180628	PCGF5	-0.105	5.10E-02
ENSG00000168496	FEN1	-0.105	8.74E-03
ENSG00000115806	GORASP2	-0.105	3.38E-03
ENSG00000075856	SART3	-0.105	1.29E-02

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ENSG00000105698	USF2	-0.105	4.39E-02
ENSG00000072062	PRKACA	-0.106	1.53E-02
ENSG00000142192	APP	-0.106	6.67E-04
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ENSG00000116209	TMEM59	-0.106	2.35E-02
ENSG00000125249	RAP2A	-0.106	4.95E-02
ENSG00000101266	CSNK2A1	-0.106	2.01E-03
ENSG00000104969	SGTA	-0.106	2.26E-02
ENSG00000112335	SNX3	-0.106	1.72E-02
ENSG00000116688	MFN2	-0.106	2.56E-03
ENSG00000029363	BCLAF1	-0.106	8.15E-03
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ENSG00000140416	TPM1	-0.108	2.28E-02
ENSG00000092199	HNRNPC	-0.108	5.26E-04
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ENSG00000068489	PRR11	-0.108	1.51E-02
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ENSG00000085449	WDFY1	-0.109	1.03E-02
ENSG00000198055	GRK6	-0.109	2.03E-02
ENSG00000130724	CHMP2A	-0.109	2.92E-02
ENSG00000100097	LGALS1	-0.109	3.11E-02

ENSG00000149554	CHEK1	-0.109	7.45E-03
ENSG00000067829	IDH3G	-0.109	4.49E-02
ENSG00000164896	FASTK	-0.109	4.65E-02
ENSG00000105323	HNRNPUL1	-0.109	1.37E-03
ENSG00000147533	GOLGA7	-0.110	1.42E-02
ENSG00000067182	TNFRSF1A	-0.110	1.84E-02
ENSG00000136827	TOR1A	-0.110	2.16E-02
ENSG00000141959	PFKL	-0.110	1.19E-02
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ENSG00000143819	EPHX1	-0.110	4.31E-02
ENSG00000177885	GRB2	-0.110	4.41E-03
ENSG00000065621	GSTO2	-0.110	4.57E-02
ENSG00000176407	KCMF1	-0.110	8.48E-03
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ENSG00000108344	PSMD3	-0.110	5.43E-03
ENSG00000006125	AP2B1	-0.110	1.00E-03
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ENSG00000117399	CDC20	-0.110	5.80E-03
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ENSG00000204394	VARS	-0.111	2.04E-02
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ENSG00000143420	ENSA	-0.111	3.22E-03
ENSG00000084652	TXLNA	-0.111	5.19E-03
ENSG00000166825	ANPEP	-0.111	2.54E-02
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ENSG00000137074	APTX	-0.130	1.29E-02
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ENSG00000163444	TMEM183A	-0.130	5.86E-03
ENSG00000163281	GNPDA2	-0.130	3.95E-02
ENSG00000136770	DNAJC1	-0.130	2.25E-02
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ENSG00000198959	TGM2	-0.150	5.35E-03
ENSG00000105329	TGFB1	-0.150	3.59E-03
ENSG00000184117	NIPSNAP1	-0.150	6.75E-03
ENSG00000108774	RAB5C	-0.150	1.24E-02
ENSG00000020577	SAMD4A	-0.150	1.55E-03
ENSG00000091986	CCDC80	-0.150	2.27E-03
ENSG00000103319	EEF2K	-0.150	1.16E-02
ENSG00000185627	PSMD13	-0.150	2.16E-03
ENSG00000196923	PDLIM7	-0.150	1.88E-03
ENSG00000183207	RUVBL2	-0.150	1.28E-03
ENSG00000114302	PRKAR2A	-0.151	5.50E-04
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ENSG00000079739	PGM1	-0.151	1.28E-03
ENSG00000109189	USP46	-0.151	3.02E-02
ENSG00000048828	FAM120A	-0.151	4.86E-05
ENSG00000157911	PEX10	-0.151	1.23E-02
ENSG00000161010	C5orf45	-0.151	2.65E-02
ENSG00000133112	TPT1	-0.151	1.24E-05
ENSG00000105221	AKT2	-0.151	4.76E-04
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ENSG00000104980	TIMM44	-0.151	6.70E-03
ENSG00000156711	MAPK13	-0.151	1.63E-03
ENSG00000072958	AP1M1	-0.151	1.61E-02
ENSG00000173207	CKS1B	-0.151	1.19E-03
ENSG00000116685	KIAA2013	-0.151	2.58E-03
ENSG00000138095	LRPPRC	-0.151	6.81E-04

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ENSG00000108846	ABCC3	-0.151	4.02E-02
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ENSG00000175390	EIF3F	-0.152	9.76E-05
ENSG00000163344	PMVK	-0.152	2.73E-02
ENSG00000161016	RPL8	-0.152	2.54E-05
ENSG00000115540	MOB4	-0.152	4.66E-02
ENSG00000140740	UQCRC2	-0.152	7.87E-05
ENSG00000151348	EXT2	-0.152	1.19E-03
ENSG00000080608	PUM3	-0.152	8.92E-04
ENSG00000186298	PPP1CC	-0.152	1.55E-03
ENSG00000126524	SBDS	-0.152	2.47E-04
ENSG00000166181	API5	-0.152	2.88E-04
ENSG00000104325	DECR1	-0.152	1.13E-02
ENSG00000109790	KLHL5	-0.152	1.34E-03
ENSG00000102572	STK24	-0.152	4.24E-05
ENSG00000147676	MAL2	-0.152	1.17E-02
ENSG00000130520	LSM4	-0.152	8.50E-04
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ENSG00000002549	LAP3	-0.152	2.09E-03
ENSG00000167468	GPX4	-0.152	3.39E-03
ENSG00000064961	HMG20B	-0.152	2.35E-03
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ENSG00000139146	FAM60A	-0.153	1.39E-03
ENSG00000141551	CSNK1D	-0.153	4.94E-05
ENSG00000092201	SUPT16H	-0.153	4.59E-05
ENSG00000186815	TPCN1	-0.153	1.54E-03
ENSG00000136897	MRPL50	-0.153	9.61E-03
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ENSG00000110063	DCPS	-0.153	1.31E-02
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ENSG00000099810	MTAP	-0.153	1.05E-03
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ENSG00000079246	XRCC5	-0.153	1.41E-05
ENSG00000162627	SNX7	-0.153	8.44E-03
ENSG00000128609	NDUFA5	-0.153	5.21E-03

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ENSG00000153179	RASSF3	-0.154	8.08E-03
ENSG00000136518	ACTL6A	-0.154	6.97E-04
ENSG00000149925	ALDOA	-0.154	1.07E-04
ENSG00000173020	ADRBK1	-0.154	1.72E-03
ENSG00000120256	LRP11	-0.154	2.19E-03
ENSG00000140264	SERF2	-0.154	2.99E-04
ENSG00000129559	NEDD8	-0.154	2.80E-02
ENSG00000115761	NOL10	-0.154	1.39E-03
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ENSG00000163527	STT3B	-0.155	6.79E-04
ENSG00000130811	EIF3G	-0.155	2.16E-04
ENSG00000130340	SNX9	-0.155	1.52E-03
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ENSG00000136943	CTSV	-0.155	3.37E-03
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ENSG00000110717	NDUFS8	-0.159	4.39E-03
ENSG00000111361	EIF2B1	-0.159	2.46E-03
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ENSG00000107164	FUBP3	-0.159	6.77E-05
ENSG00000136930	PSMB7	-0.159	9.76E-05
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ENSG00000107758	PPP3CB	-0.161	7.14E-03
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ENSG00000180370	PAK2	-0.161	2.18E-04
ENSG00000197746	PSAP	-0.161	2.17E-05
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ENSG00000103018	CYB5B	-0.161	3.17E-04
ENSG00000214113	LYRM4	-0.161	1.46E-02
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ENSG00000174891	RSRC1	-0.161	1.27E-02
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ENSG00000105426	PTPRS	-0.163	7.89E-04
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ENSG00000113389	NPR3	-0.163	2.03E-03
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ENSG00000025796	SEC63	-0.163	2.61E-04
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ENSG00000179051	RCC2	-0.164	6.54E-06
ENSG00000131236	CAP1	-0.164	6.62E-06
ENSG00000132680	KIAA0907	-0.164	3.64E-03
ENSG00000144063	MALL	-0.164	3.27E-02
ENSG00000125458	NT5C	-0.164	6.19E-03
ENSG00000087302	C14orf166	-0.164	2.50E-04
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ENSG00000152332	UHMK1	-0.164	5.94E-04
ENSG00000105939	ZC3HAV1	-0.164	4.01E-05
ENSG00000108679	LGALS3BP	-0.164	3.39E-04
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ENSG00000163714	U2SURP	-0.165	6.91E-05
ENSG00000163468	CCT3	-0.165	1.16E-05

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ENSG00000185085	INTS5	-0.165	1.53E-02
ENSG00000114383	TUSC2	-0.165	1.68E-02
ENSG00000165669	FAM204A	-0.165	6.83E-03
ENSG00000171109	MFN1	-0.165	4.87E-03
ENSG00000125753	VASP	-0.165	8.31E-04
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ENSG00000170310	STX8	-0.165	1.87E-02
ENSG00000153786	ZDHHC7	-0.165	2.13E-04
ENSG00000104529	EEF1D	-0.165	8.10E-05
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ENSG00000172785	CBWD1	-0.166	1.32E-03
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ENSG00000158604	TMED4	-0.167	2.10E-03
ENSG00000139637	C12orf10	-0.167	7.66E-03
ENSG00000144677	CTDSPL	-0.167	2.58E-04
ENSG00000129194	SOX15	-0.167	1.35E-03
ENSG00000124098	FAM210B	-0.167	2.07E-04
ENSG00000103005	USB1	-0.167	2.95E-04
ENSG00000169251	NMD3	-0.167	5.07E-03

ENSG00000117519	CNN3	-0.167	2.51E-04
ENSG00000186283	TOR3A	-0.167	6.28E-03
ENSG00000141580	WDR45B	-0.167	6.40E-05
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ENSG00000146066	HIGD2A	-0.167	5.37E-03
ENSG00000156482	RPL30	-0.167	5.59E-06
ENSG00000154511	FAM69A	-0.167	4.46E-02
ENSG00000119487	MAPKAP1	-0.167	4.80E-05
ENSG00000100714	MTHFD1	-0.168	3.27E-05
ENSG00000196655	TRAPPC4	-0.168	3.26E-02
ENSG00000165802	NSMF	-0.168	1.57E-03
ENSG00000135916	ITM2C	-0.168	3.86E-03
ENSG00000224032	EPB41L4A-AS1	-0.168	2.06E-02
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ENSG00000126602	TRAP1	-0.168	9.96E-05
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ENSG00000197702	PARVA	-0.169	1.70E-03
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ENSG00000131724	IL13RA1	-0.169	3.62E-04
ENSG00000152990	ADGRA3	-0.169	3.34E-04
ENSG00000185515	BRCC3	-0.169	3.66E-03
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ENSG00000012174	MBTPS2	-0.170	9.92E-03
ENSG00000104886	PLEKHJ1	-0.170	1.81E-02

ENSG00000116863	ADPRHL2	-0.170	7.46E-03
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ENSG00000183576	SETD3	-0.170	1.93E-03
ENSG00000167114	SLC27A4	-0.170	5.73E-03
ENSG00000113013	HSPA9	-0.170	8.39E-06
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ENSG00000164024	METAP1	-0.170	1.49E-04
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ENSG00000167702	KIFC2	-0.171	7.83E-03
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ENSG00000124784	RIOK1	-0.187	9.81E-04
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ENSG00000120675	DNAJC15	-0.188	7.14E-04
ENSG00000123130	ACOT9	-0.188	2.25E-04
ENSG00000167543	TP53I13	-0.188	2.80E-02
ENSG00000125356	NDUFA1	-0.188	2.32E-03
ENSG00000064703	DDX20	-0.188	1.27E-04
ENSG00000125398	SOX9	-0.188	2.93E-03
ENSG00000213523	SRA1	-0.188	2.14E-04
ENSG00000101182	PSMA7	-0.188	1.41E-05
ENSG00000152700	SAR1B	-0.188	1.32E-03
ENSG00000106628	POLD2	-0.188	4.40E-06
ENSG00000165283	STOML2	-0.188	3.22E-04
ENSG00000078747	ITCH	-0.188	6.29E-06
ENSG00000103326	CAPN15	-0.189	8.52E-04
ENSG00000125912	NCLN	-0.189	6.43E-04
ENSG00000103275	UBE2I	-0.189	3.08E-06
ENSG00000101193	GID8	-0.189	2.74E-05
ENSG00000175756	AURKAIP1	-0.189	3.41E-03
ENSG00000135052	GOLM1	-0.189	3.39E-05
ENSG00000110321	EIF4G2	-0.189	3.58E-07
ENSG00000166226	CCT2	-0.189	9.44E-06
ENSG00000161249	DMKN	-0.189	6.03E-05
ENSG00000170027	YWHAG	-0.189	3.49E-06
ENSG00000090863	GLG1	-0.189	4.32E-06
ENSG00000241837	ATP5O	-0.190	3.46E-02
ENSG00000166710	B2M	-0.190	1.30E-05
ENSG00000156535	CD109	-0.190	8.98E-06

ENSG00000124207	CSE1L	-0.190	5.33E-06
ENSG00000113460	BRIX1	-0.190	2.48E-05
ENSG00000163754	GYG1	-0.190	4.62E-03
ENSG00000196139	AKR1C3	-0.190	3.84E-02
ENSG00000183283	DAZAP2	-0.190	2.74E-06
ENSG00000116906	GNPAT	-0.190	1.33E-03
ENSG00000119318	RAD23B	-0.190	5.49E-06
ENSG00000125844	RRBP1	-0.190	4.23E-06
ENSG00000180185	FAHD1	-0.190	4.40E-03
ENSG00000071054	MAP4K4	-0.190	9.05E-07
ENSG00000161981	SNRNP25	-0.190	1.53E-02
ENSG00000105193	RPS16	-0.190	2.43E-06
ENSG00000112559	MDFI	-0.190	7.89E-04
ENSG00000151502	VPS26B	-0.190	1.54E-03
ENSG00000101346	POFUT1	-0.191	1.31E-06
ENSG00000179344	HLA-DQB1	-0.191	1.63E-02
ENSG00000196636	SDHAF3	-0.191	2.60E-02
ENSG00000130706	ADRM1	-0.191	1.76E-04
ENSG00000105254	TBCB	-0.191	1.43E-03
ENSG00000163528	CHCHD4	-0.191	1.39E-02
ENSG00000196549	MME	-0.191	4.63E-03
ENSG00000182534	MXRA7	-0.191	5.27E-06
ENSG00000164587	RPS14	-0.191	3.87E-06
ENSG00000125691	RPL23	-0.191	5.46E-07
ENSG00000020129	NCDN	-0.191	3.92E-04
ENSG00000055483	USP36	-0.191	1.47E-05
ENSG00000244038	DDOST	-0.191	4.84E-06
ENSG00000099194	SCD	-0.191	2.69E-07
ENSG00000114738	MAPKAPK3	-0.191	1.73E-04
ENSG00000186193	SAPCD2	-0.192	6.74E-03
ENSG00000164818	DNAAF5	-0.192	3.74E-04
ENSG00000151465	CDC123	-0.192	1.69E-05
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ENSG00000111843	TMEM14C	-0.192	2.29E-03
ENSG00000084774	CAD	-0.192	2.14E-05
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ENSG00000065150	IPO5	-0.192	6.17E-06
ENSG00000254087	LYN	-0.192	7.35E-04
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ENSG00000198042	MAK16	-0.192	6.94E-04

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ENSG00000171067	C11orf24	-0.192	5.49E-04
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ENSG00000131469	RPL27	-0.193	1.65E-05
ENSG00000136143	SUCLA2	-0.193	4.57E-03
ENSG00000162889	MAPKAPK2	-0.193	1.02E-05
ENSG00000277203	F8A1	-0.194	3.18E-02
ENSG00000161921	CXCL16	-0.194	7.48E-03
ENSG00000123933	MXD4	-0.194	2.88E-03
ENSG00000007080	CCDC124	-0.194	9.51E-04
ENSG00000167615	LENG8	-0.194	1.65E-04
ENSG00000131828	PDHA1	-0.194	1.21E-05
ENSG00000231500	RPS18	-0.194	1.85E-06
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ENSG00000179091	CYC1	-0.194	3.05E-05
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ENSG00000100410	PHF5A	-0.194	2.99E-03
ENSG00000173914	RBM4B	-0.194	1.33E-02
ENSG00000126821	SGPP1	-0.194	3.35E-03
ENSG00000105514	RAB3D	-0.194	2.31E-03
ENSG00000101608	MYL12A	-0.194	2.85E-05
ENSG00000111364	DDX55	-0.194	9.47E-04
ENSG00000115307	AUP1	-0.194	3.65E-05
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ENSG00000172586	CHCHD1	-0.194	1.77E-02
ENSG00000164933	SLC25A32	-0.194	1.83E-04
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ENSG00000116586	LAMTOR2	-0.195	9.85E-03
ENSG00000068697	LAPTM4A	-0.195	7.76E-05
ENSG00000198951	NAGA	-0.195	2.32E-03
ENSG00000188706	ZDHHC9	-0.195	1.33E-04
ENSG00000099330	OCEL1	-0.195	3.86E-02

ENSG00000180992	MRPL14	-0.195	3.64E-03
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ENSG00000106266	SNX8	-0.195	2.56E-03
ENSG00000105889	STEAP1B	-0.195	2.27E-02
ENSG00000130821	SLC6A8	-0.195	1.98E-05
ENSG00000118579	MED28	-0.195	3.44E-04
ENSG00000142937	RPS8	-0.195	1.39E-06
ENSG00000106348	IMPDH1	-0.195	2.95E-04
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ENSG00000234745	HLA-B	-0.196	8.06E-04
ENSG00000174437	ATP2A2	-0.196	1.31E-07
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ENSG00000123975	CKS2	-0.196	2.16E-04
ENSG00000048140	TSPAN17	-0.196	3.84E-04
ENSG00000135776	ABCB10	-0.196	6.77E-03
ENSG00000100422	CERK	-0.196	1.43E-03
ENSG00000165704	HPRT1	-0.196	2.56E-04
ENSG00000114391	RPL24	-0.196	2.82E-06
ENSG00000116096	SPR	-0.196	3.65E-02
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ENSG00000177556	ATOX1	-0.196	7.42E-04
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ENSG00000177707	PVRL3	-0.197	4.99E-03
ENSG00000187244	BCAM	-0.197	4.39E-03
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ENSG00000132128	LRRC41	-0.199	1.50E-04
ENSG00000161671	EMC10	-0.199	5.56E-04
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ENSG00000035687	ADSS	-0.199	2.21E-04
ENSG00000148798	INA	-0.199	1.03E-03
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ENSG00000055332	EIF2AK2	-0.199	6.21E-05
ENSG00000125901	MRPS26	-0.199	9.53E-04
ENSG00000154813	DPH3	-0.199	1.11E-03
ENSG00000100558	PLEK2	-0.199	1.43E-04
ENSG00000157227	MMP14	-0.199	8.39E-06
ENSG00000174444	RPL4	-0.199	7.28E-08
ENSG00000122140	MRPS2	-0.199	2.90E-04
ENSG00000151413	NUBPL	-0.199	2.58E-03
ENSG00000164346	NSA2	-0.199	1.60E-05
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ENSG00000164182	NDUFAF2	-0.200	3.68E-04
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ENSG00000112679	DUSP22	-0.200	2.28E-03
ENSG00000117407	ARTN	-0.200	1.44E-02
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ENSG00000146112	PPP1R18	-0.201	2.93E-06
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ENSG00000023909	GCLM	-0.201	2.29E-03
ENSG00000169446	MMGT1	-0.201	9.80E-05
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ENSG00000101000	PROCR	-0.201	1.89E-04
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ENSG00000163932	PRKCD	-0.201	5.39E-04
ENSG00000127989	MTERF1	-0.201	1.53E-02
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ENSG00000224877	C17orf89	-0.201	2.03E-02
ENSG00000164543	STK17A	-0.201	1.33E-05
ENSG00000184220	CMSS1	-0.201	5.47E-04
ENSG00000009830	POMT2	-0.201	4.43E-03
ENSG00000136938	ANP32B	-0.201	4.48E-06
ENSG00000090316	MAEA	-0.201	5.48E-05
ENSG00000237550	RPL9P9	-0.202	7.86E-04
ENSG00000065135	GNAI3	-0.202	4.89E-04
ENSG00000132164	SLC6A11	-0.202	3.97E-02
ENSG00000089356	FXYD3	-0.202	5.38E-04
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ENSG00000158805	ZNF276	-0.202	1.91E-03
ENSG00000188725	SMIM15	-0.202	1.98E-04
ENSG00000160131	VMA21	-0.202	1.24E-03
ENSG00000084090	STARD7	-0.202	4.09E-06
ENSG00000100749	VRK1	-0.202	3.72E-04
ENSG00000187109	NAP1L1	-0.202	2.05E-05

ENSG00000073536	NLE1	-0.202	1.31E-03
ENSG00000067334	DNTTIP2	-0.202	3.56E-05
ENSG00000008130	NADK	-0.202	8.07E-05
ENSG00000147684	NDUFB9	-0.202	3.88E-05
ENSG00000108784	NAGLU	-0.202	3.67E-02
ENSG00000114942	EEF1B2	-0.202	1.35E-06
ENSG00000172380	GNG12	-0.202	3.21E-05
ENSG00000146281	PM20D2	-0.202	1.26E-03
ENSG00000158669	GPAT4	-0.202	1.96E-05
ENSG00000158042	MRPL17	-0.202	4.32E-04
ENSG00000065613	SLK	-0.202	3.68E-06
ENSG00000079332	SAR1A	-0.203	5.41E-06
ENSG00000175606	TMEM70	-0.203	2.33E-02
ENSG00000076043	REXO2	-0.203	6.78E-04
ENSG00000131759	RARA	-0.203	9.45E-04
ENSG00000182240	BACE2	-0.203	4.64E-05
ENSG00000092964	DPYSL2	-0.203	4.25E-05
ENSG00000115561	CHMP3	-0.203	7.50E-05
ENSG00000168002	POLR2G	-0.203	1.64E-04
ENSG00000127184	COX7C	-0.203	9.96E-05
ENSG00000168615	ADAM9	-0.204	5.26E-06
ENSG00000125944	HNRNPR	-0.204	7.40E-07
ENSG00000106803	SEC61B	-0.204	2.81E-04
ENSG00000137288	UQCC2	-0.204	6.52E-03
ENSG00000178921	PFAS	-0.204	6.81E-05
ENSG00000091483	FH	-0.204	2.63E-04
ENSG00000180008	SOCS4	-0.204	1.05E-03
ENSG00000136305	CIDEB	-0.204	2.58E-03
ENSG00000170549	IRX1	-0.204	1.70E-02
ENSG00000111669	TPI1	-0.204	5.73E-07
ENSG00000130770	ATPIF1	-0.204	1.67E-05
ENSG00000184903	IMMP2L	-0.204	3.99E-02
ENSG00000134901	KDELC1	-0.204	8.37E-03
ENSG00000104756	KCTD9	-0.204	1.78E-05
ENSG00000162909	CAPN2	-0.204	7.49E-07
ENSG00000025800	KPNA6	-0.205	8.14E-06
ENSG00000144354	CDCA7	-0.205	7.79E-04
ENSG00000117899	MESDC2	-0.205	1.09E-04
ENSG00000113575	PPP2CA	-0.205	9.05E-06
ENSG00000180035	ZNF48	-0.205	5.84E-03
ENSG00000174780	SRP72	-0.205	1.71E-06
ENSG00000132274	TRIM22	-0.205	1.20E-02
ENSG00000146574	CCZ1B	-0.205	3.42E-02

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ENSG00000077232	DNAJC10	-0.205	2.31E-05
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ENSG00000110987	BCL7A	-0.205	5.76E-04
ENSG00000067704	IARS2	-0.205	1.52E-05
ENSG00000141574	SECTM1	-0.205	1.47E-04
ENSG00000159217	IGF2BP1	-0.205	3.42E-02
ENSG00000162706	CADM3	-0.206	1.87E-05
ENSG00000166347	CYB5A	-0.206	9.94E-03
ENSG00000143252	SDHC	-0.206	7.29E-05
ENSG00000095261	PSMD5	-0.206	5.57E-05
ENSG00000152455	SUV39H2	-0.206	2.99E-03
ENSG00000196372	ASB13	-0.206	1.92E-03
ENSG00000134330	IAH1	-0.206	1.90E-03
ENSG00000127540	UQCR11	-0.206	2.96E-02
ENSG00000119574	ZBTB45	-0.206	9.14E-03
ENSG00000112514	CUTA	-0.206	3.67E-04
ENSG00000123064	DDX54	-0.207	1.39E-05
ENSG00000187608	ISG15	-0.207	1.34E-02
ENSG00000168487	BMP1	-0.207	1.43E-04
ENSG00000141965	FEM1A	-0.207	7.56E-05
ENSG00000131446	MGAT1	-0.207	1.71E-05
ENSG00000122490	PQLC1	-0.207	2.95E-03
ENSG00000075223	SEMA3C	-0.207	6.96E-05
ENSG00000143183	TMCO1	-0.207	3.76E-05
ENSG00000085788	DDHD2	-0.207	9.78E-05
ENSG00000137411	VARS2	-0.207	2.39E-04
ENSG00000214753	HNRNPUL2	-0.207	4.02E-05
ENSG00000183978	COA3	-0.207	1.14E-03
ENSG00000009307	CSDE1	-0.207	1.43E-06
ENSG00000100304	TTLL12	-0.207	8.22E-05
ENSG00000111348	ARHGDIB	-0.208	1.32E-04
ENSG00000059378	PARP12	-0.208	3.96E-04
ENSG00000109475	RPL34	-0.208	6.61E-06
ENSG00000144120	TMEM177	-0.208	1.41E-02
ENSG00000198804	MT-CO1	-0.208	4.58E-05
ENSG00000011260	UTP18	-0.208	1.17E-03
ENSG00000174109	C16orf91	-0.208	2.55E-02
ENSG00000176386	CDC26	-0.208	1.18E-03
ENSG00000168268	NT5DC2	-0.208	1.65E-05
ENSG00000141030	COPS3	-0.208	2.11E-05
ENSG00000140983	RHOT2	-0.208	7.03E-04
ENSG00000111481	COPZ1	-0.208	2.26E-05

ENSG00000168028	RPSA	-0.208	1.28E-07
ENSG00000164062	APEH	-0.208	1.63E-05
ENSG00000198952	SMG5	-0.208	5.92E-06
ENSG00000198242	RPL23A	-0.208	6.05E-06
ENSG00000176422	SPRYD4	-0.208	3.00E-02
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ENSG00000143761	ARF1	-0.208	5.06E-06
ENSG00000171219	CDC42BPG	-0.208	1.96E-04
ENSG00000136146	MED4	-0.209	5.74E-04
ENSG00000136522	MRPL47	-0.209	3.70E-04
ENSG00000185201	IFITM2	-0.209	1.18E-05
ENSG00000084207	GSTP1	-0.209	2.31E-06
ENSG00000064666	CNN2	-0.209	6.83E-06
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ENSG00000164405	UQCRQ	-0.230	7.05E-05
ENSG00000111615	KRR1	-0.230	1.00E-05
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ENSG00000160679	CHTOP	-0.231	7.57E-06
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ENSG00000198231	DDX42	-0.231	6.26E-07
ENSG00000037757	MRI1	-0.232	4.29E-04
ENSG00000204856	FAM216A	-0.232	1.78E-03
ENSG00000111229	ARPC3	-0.232	7.30E-06
ENSG00000196937	FAM3C	-0.232	2.86E-04
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ENSG00000117411	B4GALT2	-0.232	2.65E-05
ENSG00000108671	PSMD11	-0.232	8.46E-07
ENSG00000068438	FTSJ1	-0.232	7.35E-07
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ENSG00000042445	RETSAT	-0.233	1.48E-05
ENSG00000115350	POLE4	-0.233	2.39E-03
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ENSG00000173660	UQCRH	-0.233	1.29E-06

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ENSG00000037241	RPL26L1	-0.233	4.40E-05
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ENSG00000049245	VAMP3	-0.233	2.10E-06
ENSG00000119729	RHOQ	-0.233	1.36E-04
ENSG00000133627	ACTR3B	-0.233	4.25E-02
ENSG00000164167	LSM6	-0.233	4.13E-03
ENSG00000231925	TAPBP	-0.233	8.71E-07
ENSG00000074416	MGLL	-0.233	7.35E-05
ENSG00000119013	NDUFB3	-0.233	8.50E-05
ENSG00000172922	RNASEH2C	-0.233	2.71E-03
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ENSG00000050165	DKK3	-0.233	3.90E-06
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ENSG00000105618	PRPF31	-0.234	2.97E-05
ENSG00000124172	ATP5E	-0.234	1.48E-06
ENSG00000166133	RPUSD2	-0.234	1.01E-02
ENSG00000125375	ATP5S	-0.234	1.29E-02
ENSG00000169020	ATP5I	-0.234	1.12E-03
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ENSG00000186687	LYRM7	-0.234	9.70E-05
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ENSG00000127922	SHFM1	-0.255	3.62E-06
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ENSG00000099783	HNRNPM	-0.260	1.63E-07
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ENSG00000155858	LSM11	-0.260	7.03E-04
ENSG00000101474	APMAP	-0.260	9.90E-08
ENSG00000129235	TXNDC17	-0.260	5.10E-06
ENSG00000183605	SFXN4	-0.260	1.09E-03
ENSG00000178184	PARD6G	-0.260	6.39E-04
ENSG00000123144	C19orf43	-0.260	3.03E-05
ENSG00000196363	WDR5	-0.260	1.76E-07
ENSG00000023734	STRAP	-0.261	2.29E-08
ENSG00000152558	TMEM123	-0.261	2.04E-06
ENSG00000131508	UBE2D2	-0.261	6.31E-07
ENSG00000153187	HNRNPU	-0.261	1.65E-08
ENSG00000112697	TMEM30A	-0.261	1.71E-06
ENSG00000241553	ARPC4	-0.261	5.34E-05
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ENSG00000122378	FAM213A	-0.262	1.64E-05
ENSG00000243317	C7orf73	-0.262	1.39E-05
ENSG00000107798	LIPA	-0.262	5.84E-06
ENSG00000232112	TMA7	-0.262	2.31E-06
ENSG00000064547	LPAR2	-0.262	1.57E-02
ENSG00000197951	ZNF71	-0.262	4.30E-03
ENSG00000147955	SIGMAR1	-0.262	4.02E-08
ENSG00000121057	AKAP1	-0.262	1.71E-06
ENSG00000123179	EBPL	-0.262	1.22E-04
ENSG00000165264	NDUFB6	-0.262	9.69E-04

ENSG00000130204	TOMM40	-0.262	1.37E-06
ENSG00000111605	CPSF6	-0.263	5.59E-08
ENSG00000188343	FAM92A1	-0.263	1.95E-03
ENSG00000092841	MYL6	-0.263	3.22E-08
ENSG00000119599	DCAF4	-0.263	5.87E-03
ENSG00000131778	CHD1L	-0.263	8.57E-05
ENSG00000100387	RBX1	-0.263	7.52E-04
ENSG00000166902	MRPL16	-0.263	1.15E-05
ENSG00000143418	CERS2	-0.263	2.59E-08
ENSG00000145337	PYURF	-0.263	7.78E-04
ENSG00000073578	SDHA	-0.263	2.27E-08
ENSG00000005884	ITGA3	-0.263	1.70E-08
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ENSG00000185414	MRPL30	-0.264	1.15E-05
ENSG00000161091	MFSD12	-0.264	2.21E-05
ENSG00000087842	PIR	-0.264	6.30E-03
ENSG00000132688	NES	-0.264	1.93E-03
ENSG00000113387	SUB1	-0.264	1.63E-06
ENSG00000196776	CD47	-0.264	4.74E-05
ENSG00000183161	FANCF	-0.264	7.26E-03
ENSG00000181610	MRPS23	-0.264	1.60E-05
ENSG00000174840	PDE12	-0.264	4.16E-06
ENSG00000115539	PDCL3	-0.264	9.76E-05
ENSG00000185475	TMEM179B	-0.265	5.26E-04
ENSG00000130489	SCO2	-0.265	7.56E-03
ENSG00000197312	DDI2	-0.265	1.71E-07
ENSG00000150093	ITGB1	-0.265	3.70E-09
ENSG00000124134	KCNS1	-0.265	3.74E-05
ENSG00000198729	PPP1R14C	-0.265	1.88E-06
ENSG00000105404	RABAC1	-0.265	7.42E-04
ENSG00000099800	TIMM13	-0.265	1.44E-05
ENSG00000107954	NEURL1	-0.266	3.69E-02
ENSG00000198301	SDAD1	-0.266	1.01E-06
ENSG00000164620	RELL2	-0.266	4.23E-04
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ENSG00000114023	FAM162A	-0.266	8.45E-05
ENSG00000152518	ZFP36L2	-0.266	4.05E-06
ENSG00000125827	TMX4	-0.266	8.85E-07
ENSG00000168827	GFM1	-0.267	1.33E-06

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ENSG00000184007	PTP4A2	-0.267	1.61E-07
ENSG00000130244	FAM98C	-0.267	4.62E-02
ENSG00000187605	TET3	-0.267	2.99E-07
ENSG00000138772	ANXA3	-0.267	2.67E-08
ENSG00000070950	RAD18	-0.267	2.57E-06
ENSG00000017483	SLC38A5	-0.267	7.23E-05
ENSG00000198176	TFDP1	-0.268	1.19E-08
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ENSG00000027697	IFNGR1	-0.268	5.99E-06
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ENSG00000101311	FERMT1	-0.268	6.83E-08
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ENSG00000126067	PSMB2	-0.269	8.20E-09
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ENSG00000168938	PPIC	-0.269	4.09E-05
ENSG00000185745	IFIT1	-0.269	1.02E-03
ENSG00000178741	COX5A	-0.269	1.86E-06
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ENSG00000184887	BTBD6	-0.270	1.97E-04
ENSG00000143537	ADAM15	-0.270	3.87E-06
ENSG00000114978	MOB1A	-0.270	1.20E-06
ENSG00000185650	ZFP36L1	-0.270	1.17E-08
ENSG00000110651	CD81	-0.270	5.54E-07
ENSG00000112146	FBXO9	-0.270	2.53E-05
ENSG00000162385	MAGOH	-0.270	7.01E-06
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ENSG00000160932	LY6E	-0.271	1.66E-05
ENSG00000164520	RAET1E	-0.272	6.56E-04
ENSG00000100612	DHRS7	-0.272	1.73E-06
ENSG00000206418	RAB12	-0.272	3.97E-06
ENSG00000104763	ASAH1	-0.272	1.58E-06
ENSG00000167770	OTUB1	-0.272	6.85E-06
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ENSG00000151617	EDNRA	-0.272	3.72E-03
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ENSG00000129187	DCTD	-0.273	5.41E-07
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ENSG00000158470	B4GALT5	-0.273	1.12E-07
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ENSG00000177370	TIMM22	-0.274	6.47E-06
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ENSG00000113119	TMCO6	-0.276	4.17E-04
ENSG00000162972	C2orf47	-0.276	4.05E-03
ENSG00000197457	STMN3	-0.277	2.21E-03
ENSG00000134905	CARS2	-0.277	2.35E-06
ENSG00000137720	C11orf1	-0.277	4.35E-04
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ENSG00000129911	KLF16	-0.278	3.95E-05
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ENSG00000116473	RAP1A	-0.281	1.70E-04
ENSG00000005100	DHX33	-0.282	1.26E-07
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ENSG00000159199	ATP5G1	-0.283	5.90E-07
ENSG00000214114	MYCBP	-0.283	6.03E-05
ENSG00000160818	GPATCH4	-0.283	1.10E-07
ENSG00000133641	C12orf29	-0.283	3.45E-04
ENSG00000095906	NUBP2	-0.283	4.10E-05
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ENSG00000088205	DDX18	-0.284	2.65E-07
ENSG00000026508	CD44	-0.284	5.00E-10
ENSG00000170876	TMEM43	-0.284	2.21E-07
ENSG00000136026	CKAP4	-0.284	2.29E-08
ENSG00000168884	TNIP2	-0.285	1.85E-04
ENSG00000136240	KDELR2	-0.285	6.90E-09
ENSG00000142330	CAPN10	-0.285	4.77E-03
ENSG00000123353	ORMDL2	-0.285	2.65E-05
ENSG00000115541	HSPE1	-0.285	1.74E-02
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ENSG00000242498	ARPIN	-0.285	7.21E-06
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ENSG00000146676	PURB	-0.285	4.71E-08
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ENSG00000145907	G3BP1	-0.285	4.97E-09
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ENSG00000036257	CUL3	-0.286	1.01E-06
ENSG00000152147	GEMIN6	-0.286	8.31E-04
ENSG00000105339	DENND3	-0.286	1.27E-04
ENSG00000172889	EGFL7	-0.286	3.58E-02
ENSG00000110700	RPS13	-0.286	1.42E-08
ENSG00000167625	ZNF526	-0.286	4.54E-04
ENSG00000123545	NDUFAF4	-0.287	1.04E-03
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ENSG00000157045	NTAN1	-0.288	2.24E-05
ENSG00000162980	ARL5A	-0.288	1.17E-05
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ENSG00000170854	MINA	-0.290	9.33E-06
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ENSG00000084073	ZMPSTE24	-0.290	2.13E-06
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ENSG00000111716	LDHB	-0.290	8.56E-09
ENSG00000269378	ITGB1P1	-0.290	9.86E-03
ENSG00000134001	EIF2S1	-0.290	1.86E-08
ENSG00000118680	MYL12B	-0.291	2.06E-08
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ENSG00000241399	CD302	-0.292	4.40E-03
ENSG00000184752	NDUFA12	-0.292	1.98E-06
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ENSG00000013297	CLDN11	-0.292	1.02E-03
ENSG00000181019	NQO1	-0.293	1.32E-06
ENSG00000168758	SEMA4C	-0.293	1.28E-04
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ENSG00000070423	RNF126	-0.293	5.12E-06
ENSG00000152661	GJA1	-0.293	1.17E-07
ENSG00000100985	MMP9	-0.293	2.00E-03
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ENSG00000148346	LCN2	-0.293	3.15E-02
ENSG00000070614	NDST1	-0.293	1.02E-07
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ENSG00000133316	WDR74	-0.294	1.15E-05
ENSG00000064545	TMEM161A	-0.294	2.08E-04
ENSG00000169184	MN1	-0.294	6.87E-06
ENSG00000110801	PSMD9	-0.294	2.76E-02
ENSG00000113621	TXNDC15	-0.294	7.81E-06
ENSG00000185163	DDX51	-0.294	3.47E-04
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ENSG00000211445	GPX3	-0.295	1.83E-09
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ENSG00000109133	TMEM33	-0.295	1.83E-06
ENSG00000198276	UCKL1	-0.295	5.65E-05
ENSG00000100528	CNIH1	-0.295	1.55E-06
ENSG00000104979	C19orf53	-0.295	2.11E-06
ENSG00000170860	LSM3	-0.295	8.32E-08
ENSG00000142686	C1orf216	-0.296	1.86E-04
ENSG00000111906	HDDC2	-0.296	7.05E-06
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ENSG00000105677	TMEM147	-0.297	8.56E-06
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ENSG00000120992	LYPLA1	-0.298	3.80E-05
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ENSG00000198612	COPS8	-0.298	8.80E-07
ENSG00000162704	ARPC5	-0.298	3.59E-09
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ENSG00000089195	TRMT6	-0.299	1.80E-07
ENSG00000106367	AP1S1	-0.299	1.50E-07
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ENSG00000205076	LGALS7	-0.299	1.94E-02
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ENSG00000137563	GGH	-0.299	7.15E-05
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ENSG00000142227	EMP3	-0.300	1.94E-06
ENSG00000087303	NID2	-0.300	1.86E-05
ENSG00000092820	EZR	-0.300	2.79E-10

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ENSG00000127561	SYNGR3	-0.300	4.82E-03
ENSG00000140157	NIPA2	-0.300	4.19E-07
ENSG00000129968	ABHD17A	-0.300	8.12E-06
ENSG00000172339	ALG14	-0.301	1.14E-02
ENSG00000100442	FKBP3	-0.301	3.51E-05
ENSG00000011295	TTC19	-0.301	1.98E-06
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ENSG00000107815	C10orf2	-0.301	1.05E-06
ENSG00000178567	EPM2AIP1	-0.301	2.87E-04
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ENSG00000148840	PPRC1	-0.302	8.85E-08
ENSG00000104689	TNFRSF10A	-0.302	2.23E-06
ENSG00000100697	DICER1	-0.302	6.24E-08
ENSG00000078319	PMS2P1	-0.302	4.74E-02
ENSG00000197989	SNHG12	-0.302	4.92E-04
ENSG00000116005	PCYOX1	-0.303	1.76E-07
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ENSG00000131148	EMC8	-0.303	2.83E-05
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ENSG00000134247	PTGFRN	-0.303	1.37E-09
ENSG00000166197	NOLC1	-0.303	3.89E-10
ENSG00000184209	SNRNP35	-0.303	2.03E-04
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ENSG00000180957	PITPNB	-0.311	3.18E-09
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ENSG00000188549	C15orf52	-0.354	1.18E-06
ENSG00000170855	TRIAP1	-0.354	3.04E-05
ENSG00000029993	HMGB3	-0.354	4.01E-10
ENSG00000257727	CNPY2	-0.354	2.60E-02
ENSG00000162433	AK4	-0.354	3.98E-09
ENSG00000169926	KLF13	-0.354	2.00E-09
ENSG00000116704	SLC35D1	-0.354	9.47E-06
ENSG00000054179	ENTPD2	-0.354	4.44E-04
ENSG00000128191	DGCR8	-0.354	5.68E-08
ENSG00000184500	PROS1	-0.355	7.49E-04
ENSG00000169019	COMMD8	-0.355	4.38E-03
ENSG00000028310	BRD9	-0.355	3.18E-08
ENSG00000159593	NAE1	-0.355	2.15E-07
ENSG00000265190	ANXA8	-0.355	2.13E-11
ENSG00000189433	GJB4	-0.356	2.12E-02
ENSG00000010438	PRSS3	-0.356	2.11E-03
ENSG00000123908	AGO2	-0.356	1.70E-10
ENSG00000135372	NAT10	-0.357	1.64E-09
ENSG00000226950	DANCR	-0.358	1.69E-05
ENSG00000127920	GNG11	-0.358	4.45E-02
ENSG00000147155	EBP	-0.359	2.53E-09
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ENSG00000174791	RIN1	-0.359	7.73E-08
ENSG00000100836	PABPN1	-0.359	3.64E-08
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ENSG00000110917	MLEC	-0.360	2.03E-10
ENSG00000102312	PORCN	-0.360	1.28E-08
ENSG00000167721	TSR1	-0.361	4.08E-10
ENSG00000188643	S100A16	-0.361	9.63E-11
ENSG00000107338	SHB	-0.361	1.70E-04
ENSG00000070831	CDC42	-0.361	1.78E-09
ENSG00000170545	SMAGP	-0.362	4.36E-06
ENSG00000109534	GAR1	-0.362	6.51E-06
ENSG00000104228	TRIM35	-0.362	1.74E-07
ENSG00000135318	NT5E	-0.362	3.72E-10
ENSG00000196230	TUBB	-0.363	4.82E-13

ENSG00000115364	MRPL19	-0.363	1.98E-06
ENSG00000186222	BLOC1S4	-0.363	8.19E-04
ENSG00000178951	ZBTB7A	-0.363	2.83E-08
ENSG00000135932	CAB39	-0.363	4.00E-10
ENSG00000147119	CHST7	-0.364	2.83E-02
ENSG00000111328	CDK2AP1	-0.364	6.69E-07
ENSG00000146386	ABRACL	-0.364	1.29E-06
ENSG00000157601	MX1	-0.364	1.10E-04
ENSG00000132463	GRSF1	-0.364	3.93E-08
ENSG00000145545	SRD5A1	-0.364	9.60E-06
ENSG00000126878	AIF1L	-0.365	4.29E-04
ENSG00000100522	GNPNAT1	-0.365	1.00E-07
ENSG00000105974	CAV1	-0.366	4.14E-11
ENSG00000155115	GTF3C6	-0.366	3.53E-06
ENSG00000150787	PTS	-0.366	9.61E-05
ENSG00000165474	GJB2	-0.366	1.41E-08
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ENSG00000152382	TADA1	-0.368	3.98E-04
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ENSG00000141994	DUS3L	-0.370	1.60E-06
ENSG00000143753	DEGS1	-0.370	3.09E-09
ENSG00000167394	ZNF668	-0.370	1.58E-03
ENSG00000102743	SLC25A15	-0.371	1.07E-03
ENSG00000124787	RPP40	-0.372	2.59E-05
ENSG00000198890	PRMT6	-0.372	9.48E-07
ENSG00000168556	ING2	-0.372	3.71E-06
ENSG00000228300	C19orf24	-0.372	2.97E-04
ENSG00000178922	HYI	-0.372	2.56E-06
ENSG00000075618	FSCN1	-0.372	5.17E-09
ENSG00000118971	CCND2	-0.373	2.30E-08
ENSG00000122696	SLC25A51	-0.373	1.05E-03
ENSG00000102178	UBL4A	-0.373	1.30E-07
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ENSG00000176022	B3GALT6	-0.376	2.21E-07
ENSG00000196396	PTPN1	-0.376	4.39E-12
ENSG00000107443	CCNJ	-0.376	6.57E-06
ENSG00000189334	S100A14	-0.376	5.99E-12
ENSG00000198406	BZW1P2	-0.377	2.61E-02
ENSG00000160050	CCDC28B	-0.377	1.07E-02
ENSG00000140905	GCSH	-0.378	2.72E-05

ENSG00000260549	MT1L	-0.378	1.73E-06
ENSG00000197385	ZNF860	-0.378	5.36E-04
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ENSG00000174307	PHLDA3	-0.380	6.26E-06
ENSG00000107937	GTPBP4	-0.380	1.87E-09
ENSG00000103037	SETD6	-0.380	3.72E-05
ENSG00000178695	KCTD12	-0.381	3.03E-10
ENSG00000130827	PLXNA3	-0.381	9.21E-07
ENSG00000114850	SSR3	-0.381	2.54E-10
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ENSG00000119185	ITGB1BP1	-0.385	3.69E-09
ENSG00000133101	CCNA1	-0.385	1.47E-02
ENSG00000181873	IBA57	-0.385	2.05E-05
ENSG00000129128	SPCS3	-0.386	2.14E-10
ENSG00000165060	FXN	-0.386	4.34E-04
ENSG00000050393	MCUR1	-0.386	1.61E-08
ENSG00000142279	WTIP	-0.387	7.32E-05
ENSG00000130826	DKC1	-0.387	1.04E-10
ENSG00000171476	HOPX	-0.388	4.38E-02
ENSG00000131435	PDLIM4	-0.388	3.90E-07
ENSG00000158792	SPATA2L	-0.388	6.56E-04
ENSG00000111696	NT5DC3	-0.388	3.42E-06
ENSG00000173166	RAPH1	-0.388	1.44E-10
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ENSG00000136869	TLR4	-0.389	3.27E-06
ENSG00000088726	TMEM40	-0.391	1.72E-06
ENSG00000170468	C14orf169	-0.391	7.78E-08
ENSG00000103257	SLC7A5	-0.392	9.85E-12
ENSG00000186174	BCL9L	-0.392	3.03E-10
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ENSG00000136379	ABHD17C	-0.393	2.54E-06

ENSG00000100413	POLR3H	-0.393	1.44E-07
ENSG00000188807	TMEM201	-0.393	1.04E-07
ENSG00000168890	TMEM150A	-0.394	1.30E-03
ENSG00000115598	IL1RL2	-0.394	4.71E-04
ENSG00000184207	PGP	-0.395	2.16E-06
ENSG00000091527	CDV3	-0.395	1.18E-11
ENSG00000116649	SRM	-0.395	1.89E-09
ENSG00000154518	ATP5G3	-0.396	6.07E-10
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ENSG00000196503	ARL9	-0.397	1.67E-02
ENSG00000107130	NCS1	-0.398	4.97E-09
ENSG00000004660	CAMKK1	-0.398	1.81E-05
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ENSG00000273344	PAXIP1-AS1	-0.417	1.74E-02
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ENSG00000187961	KLHL17	-0.446	2.28E-06
ENSG00000181751	C5orf30	-0.447	1.94E-06
ENSG00000180822	PSMG4	-0.447	1.65E-05
ENSG00000247077	PGAM5	-0.447	6.24E-10
ENSG00000196502	SULT1A1	-0.448	2.77E-05
ENSG00000173227	SYT12	-0.449	3.39E-05
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ENSG00000130810	PPAN	-0.454	5.42E-03
ENSG00000197362	ZNF786	-0.455	1.11E-04
ENSG00000170458	CD14	-0.456	3.74E-05
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ENSG00000186603	HPDL	-0.466	2.42E-06
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ENSG00000063660	GPC1	-0.474	3.90E-11
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ENSG00000128591	FLNC	-0.476	3.96E-08
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ENSG00000159166	LAD1	-0.490	4.59E-13
ENSG00000178127	NDUFV2	-0.492	3.08E-02
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ENSG00000138061	CYP1B1	-0.515	3.06E-13
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ENSG00000125798	FOXA2	-0.519	2.05E-05
ENSG00000165655	ZNF503	-0.523	4.21E-09
ENSG00000115841	RMDN2	-0.523	8.61E-03
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ENSG00000100285	NEFH	-0.533	2.55E-12
ENSG00000143878	RHOB	-0.534	1.22E-07
ENSG00000120913	PDLIM2	-0.536	3.13E-07
ENSG00000175768	TOMM5	-0.537	6.16E-04
ENSG00000137801	THBS1	-0.537	2.07E-13
ENSG00000085063	CD59	-0.537	1.22E-13
ENSG00000240053	LY6G5B	-0.537	7.73E-03

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ENSG00000116273	PHF13	-0.539	3.25E-10
ENSG00000163597	SNHG16	-0.540	8.93E-12
ENSG00000244687	UBE2V1	-0.541	5.11E-03
ENSG00000189420	ZFP92	-0.543	1.10E-02
ENSG00000175591	P2RY2	-0.543	4.71E-09
ENSG00000167695	FAM57A	-0.546	1.11E-12
ENSG00000142634	EFHD2	-0.546	1.70E-12
ENSG00000131016	AKAP12	-0.550	3.87E-11
ENSG00000198894	CIPC	-0.551	6.93E-07
ENSG00000166106	ADAMTS15	-0.553	6.36E-04
ENSG00000182325	FBXL6	-0.553	1.42E-06
ENSG00000048162	NOP16	-0.554	2.11E-12
ENSG00000040633	PHF23	-0.555	5.70E-11
ENSG00000176170	SPHK1	-0.557	7.43E-11
ENSG00000108244	KRT23	-0.559	2.63E-03
ENSG00000138675	FGF5	-0.559	7.56E-05
ENSG00000262814	MRPL12	-0.560	1.42E-03
ENSG00000214029	ZNF891	-0.560	3.30E-04
ENSG00000110047	EHD1	-0.560	9.39E-13
ENSG00000203896	LIME1	-0.561	2.25E-03
ENSG00000123505	AMD1	-0.563	1.19E-13
ENSG00000125775	SDCBP2	-0.566	2.08E-07
ENSG00000181619	GPR135	-0.569	2.48E-03
ENSG00000180834	MAP6D1	-0.573	3.95E-03
ENSG00000243678	NME2	-0.573	4.45E-02
ENSG00000228727	SAPCD1	-0.574	5.06E-02
ENSG00000197191	CYSRT1	-0.575	3.68E-03
ENSG00000179409	GEMIN4	-0.575	5.68E-12
ENSG00000173530	TNFRSF10D	-0.578	4.71E-12
ENSG00000229944	EIF4EP2	-0.579	1.05E-02
ENSG00000158246	FAM46B	-0.580	5.42E-09
ENSG00000111252	SH2B3	-0.581	2.94E-12
ENSG00000223749	MIR503HG	-0.582	7.85E-04
ENSG00000116741	RGS2	-0.582	3.29E-11
ENSG00000210196	MT-TP	-0.583	1.79E-03
ENSG00000110092	CCND1	-0.584	4.44E-16
ENSG00000126778	SIX1	-0.587	8.60E-09
ENSG00000149948	HMGA2	-0.588	5.44E-16
ENSG00000183114	FAM43B	-0.588	3.25E-03
ENSG00000127334	DYRK2	-0.590	2.13E-10
ENSG00000135048	TMEM2	-0.593	1.55E-12

ENSG00000197632	SERPINB2	-0.596	4.69E-14
ENSG00000155846	PPARGC1B	-0.600	5.65E-10
ENSG00000145423	SFRP2	-0.600	2.79E-03
ENSG00000087495	PHACTR3	-0.602	1.92E-06
ENSG00000167772	ANGPTL4	-0.609	8.70E-09
ENSG00000169991	IFFO2	-0.613	1.40E-13
ENSG00000164116	GUCY1A3	-0.613	4.55E-02
ENSG00000182685	BRICD5	-0.613	3.52E-03
ENSG00000188613	NANOS1	-0.613	2.89E-04
ENSG00000132603	NIP7	-0.614	1.42E-12
ENSG00000141542	RAB40B	-0.614	6.60E-06
ENSG00000140280	LYSMD2	-0.614	1.87E-04
ENSG00000184678	HIST2H2BE	-0.617	4.58E-04
ENSG00000198934	MAGEE1	-0.617	7.92E-04
ENSG00000070444	MNT	-0.617	3.14E-12
ENSG00000163463	KRTCAP2	-0.618	6.33E-04
ENSG00000179886	TIGD5	-0.620	4.34E-06
ENSG00000180447	GAS1	-0.623	1.08E-12
ENSG00000160712	IL6R	-0.623	5.28E-13
ENSG00000197162	ZNF785	-0.627	4.54E-07
ENSG00000132915	PDE6A	-0.628	1.96E-02
ENSG00000170454	KRT75	-0.629	1.78E-04
ENSG00000169851	PCDH7	-0.629	3.55E-07
ENSG00000178409	BEND3	-0.633	4.30E-09
ENSG00000138678	GPAT3	-0.634	2.89E-03
ENSG00000210195	MT-TT	-0.635	1.29E-03
ENSG00000203727	SAMD5	-0.638	1.08E-03
ENSG00000105732	ZNF574	-0.645	7.50E-10
ENSG00000255561	FDXACB1	-0.646	8.88E-03
ENSG00000217930	PAM16	-0.647	1.07E-02
ENSG00000169715	MT1E	-0.648	5.51E-14
ENSG00000100065	CARD10	-0.654	3.83E-12
ENSG00000184731	FAM110C	-0.657	9.07E-11
ENSG00000173848	NET1	-0.658	3.44E-17
ENSG00000153395	LPCAT1	-0.659	9.36E-15
ENSG00000120875	DUSP4	-0.661	1.04E-15
ENSG00000174276	ZNHIT2	-0.668	6.92E-06
ENSG00000241343	RPL36A	-0.670	6.77E-04
ENSG00000177494	ZBED2	-0.674	2.31E-13
ENSG00000104998	IL27RA	-0.681	1.24E-06
ENSG00000187193	MT1X	-0.681	2.32E-07
ENSG00000188064	WNT7B	-0.682	2.41E-08
ENSG00000197614	MFAP5	-0.682	2.93E-02

ENSG00000145860	RNF145	-0.683	2.30E-14
ENSG00000101361	NOP56	-0.690	7.25E-17
ENSG00000210117	MT-TW	-0.693	5.91E-03
ENSG00000247626	MARS2	-0.697	1.81E-08
ENSG00000203761	MSTO2P	-0.698	7.75E-04
ENSG00000184602	SNN	-0.700	8.25E-11
ENSG00000117877	CD3EAP	-0.711	7.22E-15
ENSG00000241852	C8orf58	-0.715	1.73E-07
ENSG00000171056	SOX7	-0.716	2.06E-12
ENSG00000237883	DGUOK-AS1	-0.717	1.22E-03
ENSG00000143867	OSR1	-0.729	9.85E-05
ENSG00000146858	ZC3HAV1L	-0.731	1.75E-05
ENSG00000019549	SNAI2	-0.734	8.90E-16
ENSG00000139874	SSTR1	-0.734	9.14E-04
ENSG00000174343	CHRNA9	-0.742	2.67E-06
ENSG00000117525	F3	-0.745	3.16E-17
ENSG00000273899	NOL12	-0.749	5.36E-03
ENSG00000100311	PDGFB	-0.749	4.12E-06
ENSG00000135763	URB2	-0.749	2.61E-13
ENSG00000183876	ARSI	-0.754	1.62E-10
ENSG00000169594	BNC1	-0.755	1.76E-17
ENSG00000246228	CASC8	-0.766	1.24E-03
ENSG00000115266	APC2	-0.780	3.04E-09
ENSG00000177374	HIC1	-0.780	8.59E-04
ENSG00000134954	ETS1	-0.797	6.78E-18
ENSG00000111664	GNB3	-0.802	2.80E-05
ENSG00000165507	C10orf10	-0.803	2.24E-04
ENSG00000135925	WNT10A	-0.805	4.18E-03
ENSG00000170684	ZNF296	-0.808	1.36E-08
ENSG00000137440	FGFBP1	-0.809	6.98E-18
ENSG00000196371	FUT4	-0.813	1.86E-09
ENSG00000015479	MATR3	-0.815	1.34E-03
ENSG00000170425	ADORA2B	-0.834	8.54E-12
ENSG00000186026	ZNF284	-0.839	8.76E-04
ENSG00000100628	ASB2	-0.847	2.88E-04
ENSG00000231991	ANXA2P2	-0.849	6.72E-03
ENSG00000102760	RGCC	-0.863	1.28E-04
ENSG00000128594	LRRC4	-0.868	1.84E-06
ENSG00000179431	FJX1	-0.872	3.26E-11
ENSG00000182585	EPGN	-0.874	4.55E-09
ENSG00000164086	DUSP7	-0.881	4.54E-19
ENSG00000183426	NPIPA1	-0.886	3.96E-05
ENSG00000115507	OTX1	-0.893	2.02E-10

ENSG00000199753	SNORD104	-0.897	8.14E-04
ENSG00000179041	RRS1	-0.905	1.29E-14
ENSG00000242125	SNHG3	-0.919	4.17E-13
ENSG00000161960	EIF4A1	-0.934	4.86E-07
ENSG00000179846	NKPD1	-0.937	8.56E-06
ENSG00000272767	JMJD1C-AS1	-0.940	7.70E-03
ENSG00000198695	MT-ND6	-0.950	2.66E-14
ENSG00000215012	C22orf29	-0.950	4.52E-14
ENSG00000154734	ADAMTS1	-0.957	2.05E-13
ENSG00000115756	HPCAL1	-0.964	1.79E-13
ENSG00000210151	MT-TS1	-0.966	9.48E-05
ENSG00000185614	FAM212A	-0.973	1.69E-07
ENSG00000197461	PDGFA	-0.978	5.00E-14
ENSG00000184254	ALDH1A3	-0.978	2.85E-19
ENSG00000188483	IER5L	-0.984	1.21E-11
ENSG00000178726	THBD	-0.995	3.87E-19
ENSG00000062282	DGAT2	-1.005	5.45E-09
ENSG00000249992	TMEM158	-1.043	4.60E-05
ENSG00000168906	MAT2A	-1.092	2.51E-20
ENSG00000281398	SNHG4	-1.105	5.42E-09
ENSG00000260260	SNHG19	-1.128	1.40E-04
ENSG00000136997	MYC	-1.150	2.93E-19
ENSG00000163735	CXCL5	-1.157	5.07E-06
ENSG00000188042	ARL4C	-1.241	1.31E-18
ENSG00000134363	FST	-1.252	1.82E-18
ENSG00000128045	RASL11B	-1.264	1.38E-07
ENSG00000197182	MIRLET7BHG	-1.275	4.51E-09
ENSG00000200087	SNORA73B	-1.293	1.12E-03
ENSG00000107984	DKK1	-1.337	4.36E-18
ENSG00000210127	MT-TA	-1.339	5.65E-06
ENSG00000106003	LFNG	-1.358	6.28E-10
ENSG00000246334	PRR7-AS1	-1.367	1.77E-05
ENSG00000145358	DDIT4L	-1.407	6.47E-07
ENSG00000212724	KRTAP2-3	-1.409	1.02E-06
ENSG00000210107	MT-TQ	-1.449	2.40E-09
ENSG00000204316	MRPL38	-1.480	1.45E-05
ENSG00000170961	HAS2	-1.770	6.46E-15

Table A2. List of differentially expressed genes (DEGs) 5U rhPON2 + 50 µM 3-oxo-C_{12}-HSL compared 50 µM 3-oxo-C_{12}-HSL.

Ensembl	Symbol	Log_2FC	P.val
ENSG00000225217	HSPA7	-7.507	1.02E-17
ENSG00000173110	HSPA6	-7.122	1.01E-23
ENSG00000198576	ARC	-4.704	2.92E-16
ENSG00000204389	HSPA1A	-3.552	1.23E-29
ENSG00000204388	HSPA1B	-3.198	3.60E-28
ENSG00000125998	FAM83C	-3.109	1.84E-09
ENSG00000140403	DNAJA4	-3.020	4.88E-25
ENSG00000130518	KIAA1683	-2.931	1.15E-09
ENSG00000166670	MMP10	-2.823	6.81E-10
ENSG00000232810	TNF	-2.821	7.45E-11
ENSG00000149599	DUSP15	-2.798	6.30E-10
ENSG00000187621	TCL6	-2.783	1.59E-09
ENSG00000164949	GEM	-2.781	9.91E-19
ENSG00000120738	EGR1	-2.777	2.06E-27
ENSG00000135625	EGR4	-2.735	6.67E-12
ENSG00000122877	EGR2	-2.714	3.07E-20
ENSG00000184557	SOCS3	-2.638	1.28E-21
ENSG00000064300	NGFR	-2.620	1.35E-19
ENSG00000169429	CXCL8	-2.619	1.38E-26
ENSG00000158014	SLC30A2	-2.615	6.50E-10
ENSG00000158050	DUSP2	-2.437	2.67E-19
ENSG00000123358	NR4A1	-2.394	6.93E-22
ENSG00000136244	IL6	-2.311	6.58E-19
ENSG00000153234	NR4A2	-2.293	1.63E-18
ENSG00000121068	TBX2	-2.249	9.28E-07
ENSG00000119508	NR4A3	-2.225	2.29E-11
ENSG00000128917	DLL4	-2.224	1.37E-07
ENSG00000116990	MYCL	-2.222	6.83E-16
ENSG00000120129	DUSP1	-2.219	1.07E-26
ENSG00000223361	FTH1P10	-2.218	1.58E-02
ENSG00000173391	OLR1	-2.164	2.62E-11
ENSG00000204390	HSPA1L	-2.154	3.07E-13
ENSG00000182393	IFNL1	-2.137	3.11E-06
ENSG00000139597	N4BP2L1	-2.116	6.09E-08
ENSG00000163449	TMEM169	-2.115	4.93E-07
ENSG00000132002	DNAJB1	-2.073	7.92E-27
ENSG00000149968	MMP3	-2.001	2.21E-12
ENSG00000109758	HGFAC	-1.994	1.75E-07

ENSG00000249855	EEF1A1P19	-1.986	1.34E-07
ENSG00000008516	MMP25	-1.986	9.44E-08
ENSG00000144802	NFKBIZ	-1.956	3.47E-22
ENSG00000203804	ADAMTSL4-AS1	-1.956	2.40E-07
ENSG00000267270	PARD6G-AS1	-1.893	1.29E-07
ENSG00000118503	TNFAIP3	-1.882	5.49E-27
ENSG00000140450	ARRDC4	-1.877	3.61E-21
ENSG00000162616	DNAJB4	-1.877	1.89E-19
ENSG00000039600	SOX30	-1.870	3.91E-06
ENSG00000280213	UCKL1-AS1	-1.869	1.13E-10
ENSG00000179674	ARL14	-1.840	3.78E-06
ENSG00000272734	ADIRF-AS1	-1.835	1.81E-19
ENSG00000186469	GNG2	-1.826	1.55E-10
ENSG00000169242	EFNA1	-1.823	2.59E-24
ENSG00000223547	ZNF844	-1.817	1.61E-07
ENSG00000167874	TMEM88	-1.807	6.00E-11
ENSG00000114315	HES1	-1.795	4.89E-21
ENSG00000196338	NLGN3	-1.791	6.11E-06
ENSG00000113070	HBEGF	-1.778	1.01E-23
ENSG00000172602	RND1	-1.772	1.87E-09
ENSG00000165879	FRAT1	-1.751	6.15E-09
ENSG00000120694	HSPH1	-1.731	9.71E-25
ENSG00000143507	DUSP10	-1.719	7.93E-17
ENSG00000175197	DDIT3	-1.716	1.06E-20
ENSG00000128965	CHAC1	-1.714	9.71E-22
ENSG00000198342	ZNF442	-1.712	7.20E-07
ENSG00000183508	FAM46C	-1.709	2.11E-09
ENSG00000188868	ZNF563	-1.690	1.57E-07
ENSG00000095739	BAMBI	-1.667	4.59E-06
ENSG00000164082	GRM2	-1.659	2.61E-05
ENSG00000197647	ZNF433	-1.654	9.56E-10
ENSG00000117318	ID3	-1.614	6.50E-20
ENSG00000164463	CREBRF	-1.598	1.83E-16
ENSG00000128590	DNAJB9	-1.596	3.03E-16
ENSG00000057657	PRDM1	-1.595	1.14E-17
ENSG00000162772	ATF3	-1.588	2.21E-20
ENSG00000174327	SLC16A13	-1.587	2.47E-13
ENSG00000124216	SNAI1	-1.582	9.08E-14
ENSG00000197044	ZNF441	-1.570	1.51E-14
ENSG00000111644	ACRBP	-1.567	4.02E-05
ENSG00000117425	PTCH2	-1.565	9.51E-06
ENSG00000205181	LINC00654	-1.565	1.42E-04

ENSG00000234667	ACTBP13	-1.557	5.06E-07
ENSG00000087074	PPP1R15A	-1.556	5.46E-22
ENSG00000173334	TRIB1	-1.554	3.09E-21
ENSG00000113369	ARRDC3	-1.552	1.28E-20
ENSG00000163545	NUAK2	-1.537	2.05E-17
ENSG00000198551	ZNF627	-1.512	3.00E-16
ENSG00000115738	ID2	-1.507	2.06E-07
ENSG00000119938	PPP1R3C	-1.492	3.20E-11
ENSG00000189431	RASSF10	-1.481	3.50E-08
ENSG00000143333	RGS16	-1.479	1.74E-08
ENSG00000109771	LRP2BP	-1.478	1.31E-06
ENSG00000248323	LUCAT1	-1.464	8.61E-08
ENSG00000111254	AKAP3	-1.462	1.58E-07
ENSG00000130766	SESN2	-1.462	6.25E-21
ENSG00000171223	JUNB	-1.419	1.28E-20
ENSG00000049249	TNFRSF9	-1.410	1.35E-06
ENSG00000196421	LINC00176	-1.406	3.94E-07
ENSG00000107968	MAP3K8	-1.404	3.75E-11
ENSG00000111912	NCOA7	-1.400	1.28E-20
ENSG00000100906	NFKBIA	-1.395	1.11E-23
ENSG00000197857	ZNF44	-1.387	3.09E-15
ENSG00000177606	JUN	-1.366	9.05E-21
ENSG00000218358	RAET1K	-1.365	1.10E-05
ENSG00000260941	LINC00622	-1.361	3.81E-08
ENSG00000125740	FOSB	-1.351	1.58E-16
ENSG00000179388	EGR3	-1.340	1.58E-16
ENSG00000134259	NGF	-1.337	6.61E-06
ENSG00000110944	IL23A	-1.333	1.93E-05
ENSG00000151014	NOCT	-1.316	1.44E-13
ENSG00000160570	DEDD2	-1.311	9.66E-19
ENSG00000187479	C11orf96	-1.303	1.46E-06
ENSG00000137193	PIM1	-1.295	2.02E-17
ENSG00000124635	HIST1H2BJ	-1.284	4.84E-06
ENSG00000188277	C15orf62	-1.279	1.41E-05
ENSG00000265972	TXNIP	-1.277	1.35E-19
ENSG00000108932	SLC16A6	-1.275	1.51E-10
ENSG00000163734	CXCL3	-1.273	6.01E-18
ENSG00000151929	BAG3	-1.271	2.03E-23
ENSG00000108342	CSF3	-1.268	2.20E-18
ENSG00000164406	LEAP2	-1.266	1.70E-04
ENSG00000115844	DLX2	-1.259	8.81E-12
ENSG00000114019	AMOTL2	-1.257	1.31E-18
ENSG00000084110	HAL	-1.255	2.42E-05

ENSG00000126368	NR1D1	-1.246	1.37E-19
ENSG00000164379	FOXQ1	-1.240	2.41E-12
ENSG00000188033	ZNF490	-1.238	2.82E-05
ENSG00000155090	KLF10	-1.233	1.74E-20
ENSG00000105327	BBC3	-1.231	1.34E-13
ENSG00000141682	PMAIP1	-1.226	1.89E-17
ENSG00000162892	IL24	-1.217	7.58E-13
ENSG00000198855	FICD	-1.217	7.52E-09
ENSG00000118523	CTGF	-1.210	4.08E-16
ENSG00000188818	ZDHHC11	-1.209	1.58E-07
ENSG00000099860	GADD45B	-1.198	6.83E-16
ENSG00000081041	CXCL2	-1.194	1.36E-17
ENSG00000140379	BCL2A1	-1.185	2.01E-06
ENSG00000172244	C5orf34	-1.182	1.88E-17
ENSG00000095752	IL11	-1.180	1.83E-09
ENSG00000160888	IER2	-1.170	8.65E-18
ENSG00000175155	YPEL2	-1.158	6.75E-10
ENSG00000146278	PNRC1	-1.150	3.29E-19
ENSG00000136367	ZFHX2	-1.146	5.45E-06
ENSG00000115963	RND3	-1.145	2.86E-19
ENSG00000267500	ZNF887P	-1.131	4.64E-05
ENSG00000177426	TGIF1	-1.128	1.55E-18
ENSG00000135605	TEC	-1.127	1.09E-03
ENSG00000158373	HIST1H2BD	-1.119	5.56E-08
ENSG00000171786	NHLH1	-1.118	2.88E-04
ENSG00000105649	RAB3A	-1.118	9.34E-05
ENSG00000267858	MZF1-AS1	-1.118	9.71E-05
ENSG00000089116	LHX5	-1.117	4.16E-06
ENSG00000178662	CSRNP3	-1.110	1.28E-07
ENSG00000143322	ABL2	-1.110	1.62E-17
ENSG00000170385	SLC30A1	-1.104	8.64E-18
ENSG00000258839	MC1R	-1.100	4.71E-09
ENSG00000164236	ANKRD33B	-1.100	1.36E-15
ENSG00000141622	RNF165	-1.096	3.34E-12
ENSG00000197020	ZNF100	-1.096	3.09E-12
ENSG00000007944	MYLIP	-1.095	4.18E-08
ENSG00000272168	CASC15	-1.092	1.26E-06
ENSG00000102385	DRP2	-1.091	4.91E-06
ENSG00000263006	ROCK1P1	-1.086	2.34E-04
ENSG00000253958	CLDN23	-1.079	1.45E-07
ENSG00000251022	THAP9-AS1	-1.074	4.00E-13
ENSG00000180573	HIST1H2AC	-1.068	5.58E-11
ENSG00000188177	ZC3H6	-1.067	9.99E-10

ENSG00000247746	USP51	-1.065	1.54E-05
ENSG00000159388	BTG2	-1.055	1.36E-15
ENSG00000121931	LRIF1	-1.053	9.13E-18
ENSG00000154822	PLCL2	-1.051	4.56E-05
ENSG00000185112	FAM43A	-1.046	2.09E-08
ENSG00000125812	GZF1	-1.045	5.23E-17
ENSG00000108551	RASD1	-1.044	3.29E-04
ENSG00000198435	NRARP	-1.044	3.03E-12
ENSG00000232133	IMPDH1P10	-1.043	1.87E-05
ENSG00000176697	BDNF	-1.041	8.63E-06
ENSG00000234289	H2BFS	-1.040	4.57E-06
ENSG00000073756	PTGS2	-1.039	6.97E-16
ENSG00000163874	ZC3H12A	-1.036	2.40E-19
ENSG00000149050	ZNF214	-1.033	6.99E-07
ENSG00000085514	PILRA	-1.032	1.24E-04
ENSG00000139438	FAM222A	-1.030	1.23E-05
ENSG00000181016	LSMEM1	-1.030	8.38E-04
ENSG00000120885	CLU	-1.030	2.41E-14
ENSG00000243649	CFB	-1.023	1.57E-05
ENSG00000051108	HERPUD1	-1.020	1.36E-18
ENSG00000188171	ZNF626	-1.019	2.66E-05
ENSG00000237330	RNF223	-1.019	1.08E-03
ENSG00000144655	CSRNP1	-1.009	2.23E-16
ENSG00000166669	ATF7IP2	-1.007	2.39E-06
ENSG00000135835	KIAA1614	-1.007	1.04E-05
ENSG00000214783	POLR2J4	-1.006	1.54E-04
ENSG00000184545	DUSP8	-0.999	4.05E-09
ENSG00000111859	NEDD9	-0.999	4.91E-14
ENSG00000152380	FAM151B	-0.998	9.24E-04
ENSG00000185338	SOCS1	-0.989	4.20E-04
ENSG00000171988	JMJD1C	-0.987	2.18E-18
ENSG00000144445	KANSL1L	-0.985	1.29E-10
ENSG00000110172	CHORDC1	-0.985	8.53E-16
ENSG00000198719	DLL1	-0.985	1.03E-08
ENSG00000111981	ULBP1	-0.980	2.17E-10
ENSG00000232040	ZBED9	-0.973	2.76E-08
ENSG00000149260	CAPN5	-0.973	8.10E-08
ENSG00000116741	RGS2	-0.970	5.75E-14
ENSG00000197013	ZNF429	-0.969	2.88E-04
ENSG00000187689	AMTN	-0.964	3.28E-03
ENSG00000204923	FBXO48	-0.963	2.76E-09
ENSG00000165312	OTUD1	-0.963	1.74E-10
ENSG00000167550	RHEBL1	-0.959	6.48E-07

ENSG00000240429	LRRFIP1P1	-0.959	1.68E-04
ENSG00000068976	PYGM	-0.959	6.52E-04
ENSG00000107742	SPOCK2	-0.953	1.95E-03
ENSG00000101665	SMAD7	-0.952	1.26E-13
ENSG00000235823	OLMALINC	-0.952	4.85E-12
ENSG00000130513	GDF15	-0.952	5.54E-08
ENSG00000213096	ZNF254	-0.951	1.35E-10
ENSG00000181896	ZNF101	-0.951	1.00E-11
ENSG00000184185	KCNJ12	-0.948	1.76E-10
ENSG00000159556	ISL2	-0.947	1.02E-04
ENSG00000113448	PDE4D	-0.946	3.27E-13
ENSG00000134107	BHLHE40	-0.945	1.35E-17
ENSG00000187105	HEATR4	-0.943	1.33E-03
ENSG00000231584	FAHD2CP	-0.943	2.12E-04
ENSG00000159873	CCDC117	-0.943	3.65E-09
ENSG00000125735	TNFSF14	-0.939	2.59E-05
ENSG00000277462	ZNF670	-0.936	1.09E-08
ENSG00000128564	VGF	-0.932	3.71E-06
ENSG00000153094	BCL2L11	-0.932	2.32E-12
ENSG00000130052	STARD8	-0.930	4.57E-04
ENSG00000111266	DUSP16	-0.928	2.48E-15
ENSG00000228175	GEMIN8P4	-0.926	1.06E-03
ENSG00000023839	ABCC2	-0.924	1.36E-05
ENSG00000132326	PER2	-0.924	3.55E-14
ENSG00000178809	TRIM73	-0.923	1.11E-04
ENSG00000171368	TPPP	-0.921	1.52E-03
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ENSG00000172748	ZNF596	-0.920	3.59E-05
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ENSG00000162461	SLC25A34	-0.910	9.30E-06
ENSG00000164920	OSR2	-0.906	2.07E-06
ENSG00000059728	MXD1	-0.905	6.04E-15
ENSG00000234684	SDCBP2-AS1	-0.905	4.97E-09
ENSG00000179476	C14orf28	-0.905	8.95E-06
ENSG00000108375	RNF43	-0.902	4.18E-14
ENSG00000187987	ZSCAN23	-0.901	4.58E-05
ENSG00000175426	PCSK1	-0.901	3.89E-08
ENSG00000116761	CTH	-0.901	4.25E-09
ENSG00000118292	C1orf54	-0.900	3.37E-03
ENSG00000107864	CPEB3	-0.899	1.09E-07

ENSG00000115008	IL1A	-0.897	1.27E-17
ENSG00000146232	NFKBIE	-0.897	1.97E-13
ENSG00000048052	HDAC9	-0.896	1.52E-09
ENSG00000109846	CRYAB	-0.894	1.65E-08
ENSG00000119922	IFIT2	-0.894	2.59E-15
ENSG00000125657	TNFSF9	-0.887	5.47E-06
ENSG00000169629	RGPD8	-0.883	1.04E-03
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ENSG00000080031	PTPRH	-0.880	1.82E-04
ENSG00000128342	LIF	-0.880	1.10E-17
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ENSG00000135338	LCA5	-0.878	3.27E-08
ENSG00000172738	TMEM217	-0.877	9.43E-07
ENSG00000138835	RGS3	-0.876	1.54E-12
ENSG00000186352	ANKRD37	-0.875	7.52E-06
ENSG00000119986	AVPI1	-0.872	2.63E-15
ENSG00000204947	ZNF425	-0.871	3.26E-07
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ENSG00000168772	CXXC4	-0.869	1.43E-03
ENSG00000186907	RTN4RL2	-0.869	9.06E-06
ENSG00000115009	CCL20	-0.868	1.54E-11
ENSG00000137331	IER3	-0.867	1.13E-17
ENSG00000049192	ADAMTS6	-0.864	2.63E-10
ENSG00000169155	ZBTB43	-0.863	2.92E-16
ENSG00000234390	USP27X-AS1	-0.860	1.73E-03
ENSG00000138623	SEMA7A	-0.858	3.68E-13
ENSG00000172818	OVOL1	-0.853	3.73E-13
ENSG00000130783	CCDC62	-0.848	1.24E-02
ENSG00000113742	CPEB4	-0.847	7.02E-15
ENSG00000123689	G0S2	-0.847	5.36E-18
ENSG00000181274	FRAT2	-0.846	6.74E-11
ENSG00000129514	FOXA1	-0.842	3.70E-11
ENSG00000149781	FERMT3	-0.840	1.56E-03
ENSG00000170345	FOS	-0.840	2.91E-17
ENSG00000183696	UPP1	-0.839	2.40E-19
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ENSG00000262001	DLGAP1-AS2	-0.832	4.65E-05
ENSG00000180447	GAS1	-0.830	1.00E-13
ENSG00000204815	TTC25	-0.829	6.13E-04
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ENSG00000180787	ZFP3	-0.821	2.89E-09
ENSG00000162733	DDR2	-0.820	1.87E-08
ENSG00000056277	ZNF280C	-0.820	2.34E-10

ENSG00000185022	MAFF	-0.819	1.71E-14
ENSG00000100100	PIK3IP1	-0.817	1.66E-11
ENSG00000135407	AVIL	-0.817	1.51E-04
ENSG00000187908	DMBT1	-0.814	7.14E-08
ENSG00000159885	ZNF222	-0.813	1.57E-04
ENSG00000115137	DNAJC27	-0.813	1.67E-07
ENSG00000133874	RNF122	-0.813	1.55E-04
ENSG00000186212	SOWAHB	-0.813	1.32E-03
ENSG00000099251	HSD17B7P2	-0.810	2.23E-05
ENSG00000178607	ERN1	-0.810	1.19E-14
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ENSG00000122861	PLAU	-0.801	1.97E-16
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ENSG00000225828	FAM229A	-0.786	2.58E-06
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ENSG00000178573	MAF	-0.780	4.53E-05
ENSG00000251192	ZNF674	-0.780	2.35E-06
ENSG00000198879	SFMBT2	-0.778	4.54E-04
ENSG00000112149	CD83	-0.778	2.11E-10
ENSG00000169946	ZFPM2	-0.777	5.63E-06
ENSG00000166046	TCP11L2	-0.776	1.95E-04
ENSG00000197124	ZNF682	-0.775	1.79E-03
ENSG00000184574	LPAR5	-0.775	2.03E-11
ENSG00000146426	TIAM2	-0.774	4.61E-06
ENSG00000173041	ZNF680	-0.774	1.08E-10
ENSG00000152439	ZNF773	-0.772	1.06E-04
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ENSG00000132510	KDM6B	-0.768	2.67E-14
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ENSG00000161011	SQSTM1	-0.751	3.60E-17
ENSG00000136866	ZFP37	-0.751	1.16E-05
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ENSG00000226763	SRRM5	-0.747	1.30E-02
ENSG00000105371	ICAM4	-0.747	7.32E-04
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ENSG00000162148	PPP1R32	-0.743	4.50E-03
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ENSG00000180438	TPRXL	-0.731	1.57E-03
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ENSG00000143178	TBX19	-0.729	7.83E-04
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ENSG00000119866	BCL11A	-0.728	1.78E-07
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ENSG00000110876	SELPLG	-0.722	2.26E-03
ENSG00000173451	THAP2	-0.719	8.50E-08
ENSG00000227354	RBM26-AS1	-0.717	9.32E-06
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ENSG00000172361	CFAP53	-0.715	9.29E-04
ENSG00000167232	ZNF91	-0.713	5.09E-09
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ENSG00000172687	ZNF738	-0.710	7.22E-08
ENSG00000130544	ZNF557	-0.709	2.67E-08
ENSG00000120370	GORAB	-0.709	1.66E-08
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ENSG00000164796	CSMD3	-0.707	4.67E-04
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ENSG00000086544	ITPKC	-0.703	5.99E-12
ENSG00000163362	C1orf106	-0.703	3.45E-12
ENSG00000047346	FAM214A	-0.702	3.30E-11
ENSG00000172071	EIF2AK3	-0.701	2.62E-11
ENSG00000125319	C17orf53	-0.701	2.82E-12
ENSG00000225526	MKRN2OS	-0.701	9.50E-03
ENSG00000100031	GGT1	-0.701	4.99E-03
ENSG00000145390	USP53	-0.700	2.23E-14
ENSG00000150907	FOXO1	-0.699	9.21E-11
ENSG00000196345	ZKSCAN7	-0.699	4.83E-03
ENSG00000198780	FAM169A	-0.697	2.81E-10
ENSG00000188185	LINC00265	-0.697	9.05E-08
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ENSG00000115758	ODC1	-0.696	2.26E-17
ENSG00000197872	FAM49A	-0.696	1.14E-03
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ENSG00000148841	ITPRIP	-0.694	7.64E-15
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ENSG00000109927	TECTA	-0.694	2.07E-02
ENSG00000177842	ZNF620	-0.694	6.10E-04
ENSG00000175895	PLEKHF2	-0.692	4.52E-13
ENSG00000132003	ZSWIM4	-0.692	4.37E-12
ENSG00000137393	RNF144B	-0.692	7.77E-11
ENSG00000164296	TIGD6	-0.691	4.36E-09
ENSG00000107282	APBA1	-0.690	1.02E-02
ENSG00000138764	CCNG2	-0.690	1.26E-13
ENSG00000007968	E2F2	-0.690	2.91E-10
ENSG00000189014	FAM35DP	-0.689	1.60E-02
ENSG00000172345	STARD5	-0.687	9.38E-08
ENSG00000164430	MB21D1	-0.687	2.55E-13
ENSG00000179111	HES7	-0.687	2.39E-08
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ENSG00000146233	CYP39A1	-0.685	1.05E-02
ENSG00000132823	OSER1	-0.684	6.28E-14
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ENSG00000179094	PER1	-0.676	2.75E-14
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ENSG00000167525	PROCA1	-0.674	2.06E-04
ENSG00000196757	ZNF700	-0.674	2.95E-07
ENSG00000160336	ZNF761	-0.673	4.49E-09
ENSG00000164603	C7orf60	-0.673	4.46E-07
ENSG00000129028	THAP10	-0.669	5.72E-07
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ENSG00000143067	ZNF697	-0.668	2.49E-12

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ENSG00000179454	KLHL28	-0.663	9.26E-10
ENSG00000078403	MLLT10	-0.663	1.44E-13
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ENSG00000187624	C17orf97	-0.657	6.55E-04
ENSG00000151117	TMEM86A	-0.657	9.50E-03
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ENSG00000133069	TMCC2	-0.656	3.13E-04
ENSG00000198585	NUDT16	-0.655	2.29E-12
ENSG00000108506	INTS2	-0.654	3.21E-11
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ENSG00000179826	MRGPRX3	-0.651	7.91E-09
ENSG00000128016	ZFP36	-0.651	6.04E-15
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ENSG00000136603	SKIL	-0.648	2.26E-12
ENSG00000198039	ZNF273	-0.648	1.16E-05
ENSG00000136881	BAAT	-0.648	1.70E-02
ENSG00000162407	PLPP3	-0.648	6.10E-06
ENSG00000171606	ZNF274	-0.647	1.62E-13
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ENSG00000151687	ANKAR	-0.647	6.93E-04
ENSG00000143457	GOLPH3L	-0.647	1.76E-10
ENSG00000081181	ARG2	-0.645	2.24E-11
ENSG00000183783	KCTD8	-0.645	2.73E-03
ENSG00000189120	SP6	-0.644	7.64E-06
ENSG00000063127	SLC6A16	-0.644	3.16E-02

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ENSG00000028277	POU2F2	-0.638	1.22E-03
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ENSG00000165617	DACT1	-0.637	1.44E-02
ENSG00000131849	ZNF132	-0.637	1.32E-03
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ENSG00000163009	C2orf48	-0.636	7.07E-03
ENSG00000217128	FNIP1	-0.635	9.20E-13
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ENSG00000160588	MPZL3	-0.632	1.59E-10
ENSG00000150457	LATS2	-0.631	1.89E-10
ENSG00000113916	BCL6	-0.629	3.53E-10
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ENSG00000105136	ZNF419	-0.624	1.61E-04
ENSG00000102804	TSC22D1	-0.623	7.89E-16
ENSG00000133639	BTG1	-0.621	7.76E-12
ENSG00000069712	KIAA1107	-0.620	1.51E-04
ENSG00000180626	ZNF594	-0.620	1.03E-05
ENSG00000196569	LAMA2	-0.618	5.18E-03
ENSG00000166704	ZNF606	-0.618	3.00E-04
ENSG00000002016	RAD52	-0.616	1.71E-06
ENSG00000164741	DLC1	-0.616	1.08E-09
ENSG00000104313	EYA1	-0.615	2.18E-07
ENSG00000215908	CROCCP2	-0.615	1.67E-09
ENSG00000105497	ZNF175	-0.614	2.69E-07
ENSG00000251369	ZNF550	-0.614	1.36E-06
ENSG00000149346	SLX4IP	-0.613	4.98E-08
ENSG00000179148	ALOXE3	-0.612	5.66E-06
ENSG00000196724	ZNF418	-0.611	9.76E-03
ENSG00000112182	BACH2	-0.610	7.17E-10
ENSG00000117479	SLC19A2	-0.610	9.60E-09
ENSG00000142528	ZNF473	-0.609	3.48E-11
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ENSG00000164400	CSF2	-0.603	6.74E-04
ENSG00000135362	PRR5L	-0.603	1.49E-05
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ENSG00000185133	INPP5J	-0.598	1.56E-04
ENSG00000222009	BTBD19	-0.597	2.49E-07
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ENSG00000198482	ZNF808	-0.592	1.83E-06
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ENSG00000214226	C17orf67	-0.590	1.35E-04
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ENSG00000114541	FRMD4B	-0.586	1.83E-14
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ENSG00000185947	ZNF267	-0.576	1.07E-09
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ENSG00000101977	MCF2	-0.573	4.66E-02
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ENSG00000155760	FZD7	-0.571	9.69E-06
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ENSG00000164309	CMYA5	-0.556	3.84E-03
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ENSG00000154451	GBP5	-0.488	1.97E-03
ENSG00000138311	ZNF365	-0.488	4.13E-03
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ENSG00000183309	ZNF623	-0.484	5.55E-09
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ENSG00000258708	SLC25A21-AS1	-0.480	1.62E-02
ENSG00000264575	LINC00526	-0.480	4.44E-02
ENSG00000147912	FBXO10	-0.479	1.20E-02
ENSG00000204604	ZNF468	-0.479	5.04E-07
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ENSG00000083838	ZNF446	-0.477	1.07E-03
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ENSG00000122254	HS3ST2	-0.463	1.16E-02
ENSG00000240303	ACAD11	-0.462	4.52E-02
ENSG00000162105	SHANK2	-0.462	1.24E-03
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ENSG00000165259	HDX	-0.427	4.14E-03
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ENSG00000177683	THAP5	-0.424	6.56E-09
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ENSG00000173918	C1QTNF1	-0.419	1.23E-03
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ENSG00000135968	GCC2	-0.419	3.89E-09
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ENSG00000205464	ATP6AP1L	-0.414	1.32E-03
ENSG00000197019	SERTAD1	-0.414	6.22E-08
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ENSG00000123636	BAZ2B	-0.412	3.20E-10
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ENSG00000110497	AMBRA1	-0.406	1.09E-08
ENSG00000100739	BDKRB1	-0.406	4.66E-02
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ENSG00000171224	C10orf35	-0.405	1.83E-02
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ENSG00000161298	ZNF382	-0.403	3.72E-02
ENSG00000184224	C11orf72	-0.402	1.83E-02
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ENSG00000196418	ZNF124	-0.401	2.73E-03
ENSG00000134138	MEIS2	-0.401	1.68E-04
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ENSG00000229320	KRT8P12	-0.400	2.34E-03
ENSG00000137502	RAB30	-0.400	2.53E-05
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ENSG00000123411	IKZF4	-0.399	1.69E-04
ENSG00000133401	PDZD2	-0.398	1.27E-07
ENSG00000149257	SERPINH1	-0.398	2.17E-11
ENSG00000170153	RNF150	-0.398	2.36E-04
ENSG00000164758	MED30	-0.398	1.12E-03
ENSG00000132669	RIN2	-0.398	3.11E-09
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ENSG00000130775	THEMIS2	-0.396	1.05E-02
ENSG00000143384	MCL1	-0.396	9.35E-13
ENSG00000185697	MYBL1	-0.396	5.06E-07
ENSG00000109572	CLCN3	-0.396	1.42E-09
ENSG00000158158	CNNM4	-0.396	2.00E-07
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ENSG00000005238	FAM214B	-0.396	2.39E-08
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ENSG00000165185	KIAA1958	-0.394	2.13E-04
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ENSG00000139618	BRCA2	-0.393	1.18E-09
ENSG00000176678	FOXL1	-0.393	8.42E-05
ENSG00000119042	SATB2	-0.393	9.89E-05
ENSG00000114988	LMAN2L	-0.392	1.36E-05
ENSG00000214174	AMZ2P1	-0.392	2.63E-02
ENSG00000268043	NBPF12	-0.392	2.71E-04
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ENSG00000115998	C2orf42	-0.390	9.06E-05
ENSG00000120868	APAF1	-0.390	5.55E-07
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ENSG00000085433	WDR47	-0.389	1.93E-06
ENSG00000146350	TBC1D32	-0.389	4.04E-03
ENSG00000066827	ZFAT	-0.389	1.18E-04

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ENSG00000115183	TANC1	-0.388	1.35E-10
ENSG00000135999	EPC2	-0.388	1.10E-07
ENSG00000177200	CHD9	-0.387	1.20E-10
ENSG00000168944	CEP120	-0.387	3.42E-08
ENSG00000081320	STK17B	-0.387	3.15E-08
ENSG00000127666	TICAM1	-0.387	1.41E-06
ENSG00000185917	SETD4	-0.386	5.00E-05
ENSG00000180881	CAPS2	-0.386	1.85E-02
ENSG00000019186	CYP24A1	-0.386	3.02E-05
ENSG00000103995	CEP152	-0.386	3.95E-07
ENSG00000188785	ZNF548	-0.386	5.40E-04
ENSG00000137449	CPEB2	-0.386	3.98E-06
ENSG00000183150	GPR19	-0.386	2.90E-03
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ENSG00000174206	C12orf66	-0.386	4.30E-04
ENSG00000204991	SPIRE2	-0.385	1.82E-02
ENSG00000184271	POU6F1	-0.385	3.55E-02
ENSG00000116497	S100PBP	-0.385	8.33E-08
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ENSG00000165195	PIGA	-0.384	2.33E-07
ENSG00000033327	GAB2	-0.384	9.77E-04
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ENSG00000205659	LIN52	-0.383	5.88E-06
ENSG00000112242	E2F3	-0.383	6.52E-09
ENSG00000171877	FRMD5	-0.383	4.13E-02
ENSG00000153294	ADGRF4	-0.382	1.40E-05
ENSG00000100439	ABHD4	-0.382	2.17E-07
ENSG00000109193	SULT1E1	-0.381	6.11E-03
ENSG00000176531	PHLDB3	-0.381	1.52E-03
ENSG00000011332	DPF1	-0.381	2.00E-02
ENSG00000092871	RFFL	-0.380	7.46E-06
ENSG00000113739	STC2	-0.380	1.04E-11
ENSG00000081026	MAGI3	-0.380	1.66E-07
ENSG00000100592	DAAM1	-0.380	3.66E-07
ENSG00000124613	ZNF391	-0.380	7.08E-05
ENSG00000081189	MEF2C	-0.380	9.64E-03
ENSG00000031691	CENPQ	-0.380	1.72E-05
ENSG00000069493	CLEC2D	-0.380	1.93E-02
ENSG00000270069	MIR222HG	-0.379	9.19E-04
ENSG00000253797	UTP14C	-0.379	3.96E-06
ENSG00000137145	DENND4C	-0.379	6.31E-09

ENSG00000062716	VMP1	-0.379	1.59E-09
ENSG00000153790	C7orf31	-0.379	3.25E-04
ENSG00000267278	MAP3K14-AS1	-0.379	2.90E-02
ENSG00000112624	GLTSCR1L	-0.379	2.24E-05
ENSG00000174652	ZNF266	-0.378	6.37E-05
ENSG00000184949	FAM227A	-0.378	4.20E-02
ENSG00000168005	C11orf84	-0.378	1.02E-06
ENSG00000158966	CACHD1	-0.378	2.46E-04
ENSG00000196922	ZNF252P	-0.377	4.25E-07
ENSG00000159200	RCAN1	-0.377	3.77E-07
ENSG00000178498	DTX3	-0.377	3.24E-05
ENSG00000075539	FRYL	-0.377	2.47E-09
ENSG00000164104	HMGB2	-0.377	3.40E-10
ENSG00000247708	STX18-AS1	-0.377	6.52E-03
ENSG00000179021	C3orf38	-0.376	2.60E-07
ENSG00000196352	CD55	-0.376	9.38E-10
ENSG00000171612	SLC25A33	-0.376	9.27E-05
ENSG00000152223	EPG5	-0.376	4.59E-08
ENSG00000120539	MASTL	-0.376	5.37E-09
ENSG00000135164	DMTF1	-0.376	2.36E-09
ENSG00000112245	PTP4A1	-0.376	3.63E-09
ENSG00000212916	MAP10	-0.376	4.87E-02
ENSG00000095397	DFNB31	-0.375	3.90E-03
ENSG00000100842	EFS	-0.375	1.23E-05
ENSG00000147118	ZNF182	-0.375	9.11E-05
ENSG00000197372	ZNF675	-0.375	5.21E-04
ENSG00000076604	TRAF4	-0.375	2.54E-08
ENSG00000166446	CDYL2	-0.375	6.41E-06
ENSG00000083799	CYLD	-0.375	5.91E-09
ENSG00000181798	LINC00471	-0.374	2.86E-02
ENSG00000196588	MKL1	-0.374	2.49E-08
ENSG00000187764	SEMA4D	-0.374	7.20E-03
ENSG00000085185	BCORL1	-0.373	2.92E-06
ENSG00000159216	RUNX1	-0.373	5.43E-09
ENSG00000169239	CA5B	-0.373	2.54E-03
ENSG00000163635	ATXN7	-0.373	2.07E-09
ENSG00000204685	STARD7-AS1	-0.373	1.97E-02
ENSG00000130338	TULP4	-0.372	1.54E-07
ENSG00000153814	JAZF1	-0.372	7.66E-05
ENSG00000152503	TRIM36	-0.372	8.55E-03
ENSG00000164284	GRPEL2	-0.371	1.20E-07
ENSG00000129472	RAB2B	-0.371	6.47E-06
ENSG00000198521	ZNF43	-0.371	1.34E-02

ENSG00000175691	ZNF77	-0.371	2.62E-02
ENSG00000140987	ZSCAN32	-0.370	9.07E-06
ENSG00000138658	ZGRF1	-0.370	1.76E-06
ENSG00000096717	SIRT1	-0.370	3.06E-07
ENSG00000005339	CREBBP	-0.370	1.13E-09
ENSG00000151883	PARP8	-0.370	2.60E-06
ENSG00000204438	GPANK1	-0.370	7.28E-07
ENSG00000112200	ZNF451	-0.370	3.68E-08
ENSG00000131015	ULBP2	-0.369	5.17E-04
ENSG00000181472	ZBTB2	-0.369	1.15E-07
ENSG00000188493	C19orf54	-0.369	1.01E-04
ENSG00000148737	TCF7L2	-0.369	4.84E-08
ENSG00000142556	ZNF614	-0.369	5.30E-05
ENSG00000226688	ENTPD1-AS1	-0.369	1.09E-04
ENSG00000183647	ZNF530	-0.368	5.48E-03
ENSG00000183496	MEX3B	-0.368	7.99E-03
ENSG00000139636	LMBR1L	-0.368	7.57E-04
ENSG00000135365	PHF21A	-0.367	4.45E-08
ENSG00000213020	ZNF611	-0.367	4.83E-03
ENSG00000175764	TTLL11	-0.367	7.67E-06
ENSG00000162994	CLHC1	-0.367	1.08E-02
ENSG00000070269	TMEM260	-0.367	5.26E-05
ENSG00000256294	ZNF225	-0.367	1.48E-02
ENSG00000198598	MMP17	-0.367	3.09E-02
ENSG00000121486	TRMT1L	-0.366	1.53E-06
ENSG00000196684	HSH2D	-0.366	4.40E-03
ENSG00000210082	MT-RNR2	-0.366	8.93E-10
ENSG00000241015	TPM3P9	-0.365	5.77E-03
ENSG00000143127	ITGA10	-0.365	1.91E-02
ENSG00000146872	TLK2	-0.364	2.10E-08
ENSG00000198417	MT1F	-0.364	3.36E-02
ENSG00000108557	RAI1	-0.364	4.72E-08
ENSG00000030419	IKZF2	-0.364	4.54E-04
ENSG00000157657	ZNF618	-0.363	7.60E-07
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ENSG00000135736	CCDC102A	-0.361	2.44E-02
ENSG00000168014	C2CD3	-0.361	2.95E-07
ENSG00000168152	THAP9	-0.361	4.31E-03
ENSG00000105287	PRKD2	-0.361	7.47E-08
ENSG00000158220	ESYT3	-0.361	2.81E-02
ENSG00000185219	ZNF445	-0.360	5.06E-06
ENSG00000100577	GSTZ1	-0.360	9.34E-04
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ENSG00000180263	FGD6	-0.359	6.41E-09
ENSG00000176641	RNF152	-0.359	4.56E-04
ENSG00000145780	FEM1C	-0.359	5.41E-08
ENSG00000105516	DBP	-0.359	1.88E-02
ENSG00000101670	LIPG	-0.359	4.42E-07
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ENSG00000161551	ZNF577	-0.357	1.03E-03
ENSG00000117266	CDK18	-0.357	2.67E-04
ENSG00000016391	CHDH	-0.357	4.29E-03
ENSG00000166004	CEP295	-0.357	8.06E-08
ENSG00000167562	ZNF701	-0.356	7.68E-04
ENSG00000146263	MMS22L	-0.356	1.51E-07
ENSG00000170653	ATF7	-0.356	1.07E-07
ENSG00000143494	VASH2	-0.356	3.25E-02
ENSG00000124177	CHD6	-0.356	1.64E-09
ENSG00000127129	EDN2	-0.356	2.89E-02
ENSG00000085274	MYNN	-0.356	8.76E-06
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ENSG00000111961	SASH1	-0.355	7.61E-06
ENSG00000167981	ZNF597	-0.355	1.41E-03
ENSG00000169379	ARL13B	-0.355	7.13E-06
ENSG00000205765	C5orf51	-0.355	2.81E-08
ENSG00000172671	ZFAND4	-0.355	6.54E-03
ENSG00000167528	ZNF641	-0.355	1.03E-05
ENSG00000079308	TNS1	-0.355	4.52E-05
ENSG00000153046	CDYL	-0.355	7.62E-09
ENSG00000111785	RIC8B	-0.354	3.23E-05
ENSG00000170542	SERPINB9	-0.354	4.70E-03
ENSG00000153975	ZUFSP	-0.354	1.05E-05
ENSG00000038382	TRIO	-0.353	4.97E-09
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ENSG00000170776	AKAP13	-0.352	2.88E-09
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ENSG00000116717	GADD45A	-0.351	1.28E-08
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ENSG00000144395	CCDC150	-0.334	5.07E-03
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ENSG00000147905	ZCCHC7	-0.333	2.78E-07
ENSG00000183735	TBK1	-0.333	2.74E-07
ENSG00000129197	RPAIN	-0.333	2.90E-04
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ENSG00000008311	AASS	-0.331	6.31E-04
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ENSG00000001460	STPG1	-0.331	4.01E-06
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ENSG00000146950	SHROOM2	-0.329	1.83E-05
ENSG00000101544	ADNP2	-0.329	3.81E-08
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ENSG00000123352	SPATS2	-0.329	4.20E-08
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ENSG00000151612	ZNF827	-0.329	4.35E-06
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ENSG00000215883	CYB5RL	-0.326	4.70E-02
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ENSG00000137218	FRS3	-0.326	1.13E-02
ENSG00000147124	ZNF41	-0.326	7.45E-06
ENSG00000104880	ARHGEF18	-0.326	3.20E-03

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ENSG00000160094	ZNF362	-0.319	6.41E-05
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ENSG00000132376	INPP5K	-0.315	1.30E-04
ENSG00000188015	S100A3	-0.315	6.14E-04
ENSG00000140543	DET1	-0.315	5.00E-02
ENSG00000114739	ACVR2B	-0.314	3.17E-03
ENSG00000095574	IKZF5	-0.314	1.94E-05
ENSG00000168003	SLC3A2	-0.314	2.49E-08
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ENSG00000187609	EXD3	-0.313	1.28E-02
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ENSG00000169193	CCDC126	-0.312	3.74E-02
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ENSG00000181982	CCDC149	-0.312	3.91E-02
ENSG00000133466	C1QTNF6	-0.312	1.93E-03
ENSG00000052126	PLEKHA5	-0.312	9.90E-08
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ENSG00000177283	FZD8	-0.311	1.41E-03
ENSG00000067798	NAV3	-0.311	1.85E-02
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ENSG00000182400	TRAPPC6B	-0.311	2.14E-06
ENSG00000160352	ZNF714	-0.310	1.07E-04
ENSG00000114933	INO80D	-0.310	8.23E-07
ENSG00000131051	RBM39	-0.309	1.23E-09
ENSG00000171045	TSNARE1	-0.309	2.03E-02
ENSG00000083750	RRAGB	-0.309	1.06E-02
ENSG00000156521	TYSND1	-0.309	4.79E-05
ENSG00000117036	ETV3	-0.309	2.18E-07
ENSG00000174606	ANGEL2	-0.309	2.45E-05
ENSG00000245532	NEAT1	-0.308	2.36E-04
ENSG00000109819	PPARGC1A	-0.308	3.77E-03

ENSG00000151657	KIN	-0.308	1.10E-04
ENSG00000173575	CHD2	-0.308	2.13E-09
ENSG00000109944	C11orf63	-0.308	2.05E-02
ENSG00000112282	MED23	-0.308	1.95E-06
ENSG00000225614	ZNF469	-0.308	4.86E-02
ENSG00000062194	GPBP1	-0.308	1.37E-07
ENSG00000189143	CLDN4	-0.308	2.48E-03
ENSG00000130921	C12orf65	-0.307	9.84E-05
ENSG00000165171	WBSCR27	-0.307	4.19E-02
ENSG00000118518	RNF146	-0.307	4.21E-05
ENSG00000172007	RAB33B	-0.307	1.58E-04
ENSG00000105866	SP4	-0.307	1.33E-04
ENSG00000128487	SPECC1	-0.306	5.25E-08
ENSG00000110046	ATG2A	-0.306	1.16E-05
ENSG00000121988	ZRANB3	-0.306	2.78E-04
ENSG00000166750	SLFN5	-0.306	1.33E-08
ENSG00000074054	CLASP1	-0.305	2.50E-09
ENSG00000112837	TBX18	-0.305	1.33E-04
ENSG00000196652	ZKSCAN5	-0.304	1.15E-06
ENSG00000163617	CCDC191	-0.304	2.47E-02
ENSG00000171444	MCC	-0.304	2.17E-08
ENSG00000125386	FAM193A	-0.304	5.43E-07
ENSG00000144749	LRIG1	-0.304	8.20E-04
ENSG00000132359	RAP1GAP2	-0.304	5.88E-07
ENSG00000164695	CHMP4C	-0.304	5.91E-05
ENSG00000146757	ZNF92	-0.303	4.89E-03
ENSG00000084731	KIF3C	-0.303	5.44E-05
ENSG00000143842	SOX13	-0.303	1.56E-05
ENSG00000234420	ZNF37BP	-0.303	1.25E-04
ENSG00000006704	GTF2IRD1	-0.302	4.26E-07
ENSG00000076650	GPATCH1	-0.302	1.71E-04
ENSG00000186017	ZNF566	-0.302	1.50E-02
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ENSG00000175395	ZNF25	-0.302	8.88E-03
ENSG00000198265	HELZ	-0.302	2.40E-08
ENSG00000174799	CEP135	-0.302	3.61E-05
ENSG00000196526	AFAP1	-0.302	7.19E-06
ENSG00000182993	C12orf60	-0.302	4.19E-02
ENSG00000185924	RTN4RL1	-0.302	1.20E-02
ENSG00000020633	RUNX3	-0.302	1.83E-02
ENSG00000124374	PAIP2B	-0.302	2.37E-02

ENSG00000094804	CDC6	-0.302	8.71E-08
ENSG00000165424	ZCCHC24	-0.302	3.59E-03
ENSG00000105483	CARD8	-0.301	2.47E-03
ENSG00000245060	LINC00847	-0.301	4.43E-03
ENSG00000151065	DCP1B	-0.301	3.95E-04
ENSG00000044574	HSPA5	-0.301	1.06E-09
ENSG00000182752	PAPPA	-0.300	2.97E-04
ENSG00000189190	ZNF600	-0.300	8.98E-03
ENSG00000179406	LINC00174	-0.300	2.10E-02
ENSG00000089177	KIF16B	-0.300	2.23E-06
ENSG00000149548	CCDC15	-0.299	9.40E-04
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ENSG00000151090	THRB	-0.299	2.02E-04
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ENSG00000157741	UBN2	-0.298	1.47E-05
ENSG00000109452	INPP4B	-0.298	1.08E-06
ENSG00000138468	SENP7	-0.298	9.93E-04
ENSG00000168300	PCMTD1	-0.298	1.47E-04
ENSG00000159459	UBR1	-0.298	3.21E-06
ENSG00000197037	ZSCAN25	-0.297	7.30E-05
ENSG00000158793	NIT1	-0.297	2.62E-05
ENSG00000125430	HS3ST3B1	-0.297	1.13E-02
ENSG00000169435	RASSF6	-0.297	6.81E-04
ENSG00000170456	DENND5B	-0.297	1.70E-04
ENSG00000107104	KANK1	-0.297	4.05E-08
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ENSG00000023330	ALAS1	-0.295	5.57E-07
ENSG00000127452	FBXL12	-0.295	1.12E-04
ENSG00000204084	INPP5B	-0.295	1.78E-03
ENSG00000142627	EPHA2	-0.295	1.10E-07
ENSG00000143850	PLEKHA6	-0.295	1.05E-02
ENSG00000172869	DMXL1	-0.295	1.31E-06
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ENSG00000115042	FAHD2A	-0.294	1.52E-03
ENSG00000115020	PIKFYVE	-0.294	2.31E-06
ENSG00000241839	PLEKHO2	-0.294	8.49E-05

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ENSG00000114127	XRN1	-0.293	1.37E-05
ENSG00000171914	TLN2	-0.293	2.31E-02
ENSG00000176182	MYPOP	-0.293	6.02E-03
ENSG00000026559	KCNG1	-0.293	2.07E-03
ENSG00000189308	LIN54	-0.292	7.88E-06
ENSG00000133065	SLC41A1	-0.292	1.67E-07
ENSG00000176148	TCP11L1	-0.292	1.19E-04
ENSG00000065328	MCM10	-0.292	1.38E-07
ENSG00000171617	ENC1	-0.292	3.36E-05
ENSG00000162971	TYW5	-0.292	6.30E-04
ENSG00000010818	HIVEP2	-0.292	9.66E-09
ENSG00000197275	RAD54B	-0.292	1.93E-02
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ENSG00000139793	MBNL2	-0.291	4.42E-05
ENSG00000115504	EHBP1	-0.291	9.31E-09
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ENSG00000172167	MTBP	-0.290	5.57E-05
ENSG00000130147	SH3BP4	-0.290	2.71E-08
ENSG00000168310	IRF2	-0.290	2.25E-05
ENSG00000157184	CPT2	-0.290	1.65E-05
ENSG00000157036	EXOG	-0.290	1.51E-03
ENSG00000072422	RHOBTB1	-0.289	3.19E-03
ENSG00000148426	PROSER2	-0.288	9.20E-07
ENSG00000116731	PRDM2	-0.288	1.19E-07
ENSG00000186272	ZNF17	-0.288	3.64E-02
ENSG00000130529	TRPM4	-0.288	1.15E-03
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ENSG00000143379	SETDB1	-0.287	9.11E-07
ENSG00000197937	ZNF347	-0.287	4.83E-03
ENSG00000185019	UBOX5	-0.287	5.71E-03
ENSG00000148572	NRBF2	-0.287	7.49E-05
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ENSG00000107372	ZFAND5	-0.285	1.26E-06
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ENSG00000078804	TP53INP2	-0.284	1.17E-05
ENSG00000176208	ATAD5	-0.284	1.13E-04
ENSG00000101343	CRNKL1	-0.284	1.75E-06
ENSG00000160058	BSDC1	-0.284	1.29E-06
ENSG00000042317	SPATA7	-0.284	1.34E-02
ENSG00000197283	SYNGAP1	-0.284	1.08E-05
ENSG00000133812	SBF2	-0.283	3.62E-06
ENSG00000135679	MDM2	-0.283	1.15E-06
ENSG00000140836	ZFHX3	-0.283	3.36E-05
ENSG00000106948	AKNA	-0.283	6.02E-03
ENSG00000124496	TRERF1	-0.283	5.56E-07
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ENSG00000181038	METTL23	-0.281	1.48E-02
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ENSG00000106829	TLE4	-0.280	1.30E-03
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ENSG00000241058	NSUN6	-0.279	1.68E-03
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ENSG00000151136	BTBD11	-0.274	2.91E-03
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ENSG00000140443	IGF1R	-0.273	2.51E-07
ENSG00000117569	PTBP2	-0.273	3.55E-03

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ENSG00000107938	EDRF1	-0.273	1.93E-05
ENSG00000165572	KBTBD6	-0.272	1.56E-04
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ENSG00000103657	HERC1	-0.272	9.40E-06
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ENSG00000214293	APTR	-0.271	2.13E-02
ENSG00000116885	OSCP1	-0.271	3.62E-02
ENSG00000166169	POLL	-0.271	2.52E-03
ENSG00000114861	FOXP1	-0.271	5.87E-06
ENSG00000110237	ARHGEF17	-0.271	3.77E-05
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ENSG00000114735	HEMK1	-0.270	1.64E-03
ENSG00000163872	YEATS2	-0.270	3.18E-07
ENSG00000117597	DIEXF	-0.270	2.01E-06
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ENSG00000164142	FAM160A1	-0.269	3.83E-04
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ENSG00000023171	GRAMD1B	-0.269	6.87E-05
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ENSG00000173230	GOLGB1	-0.268	2.03E-07
ENSG00000138346	DNA2	-0.268	2.67E-04
ENSG00000107537	PHYH	-0.267	2.44E-03

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ENSG00000139211	AMIGO2	-0.267	4.48E-05
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ENSG00000140396	NCOA2	-0.264	3.61E-05
ENSG00000111860	CEP85L	-0.264	2.74E-02
ENSG00000139746	RBM26	-0.264	1.55E-06
ENSG00000088387	DOCK9	-0.263	5.32E-07
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ENSG00000175318	GRAMD2	-0.263	2.62E-03
ENSG00000112110	MRPL18	-0.263	1.36E-06
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ENSG00000011566	MAP4K3	-0.261	2.65E-04
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ENSG00000105173	CCNE1	-0.261	1.95E-03
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ENSG00000198018	ENTPD7	-0.260	4.37E-05
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ENSG00000149016	TUT1	-0.259	6.31E-03
ENSG00000136932	TRMO	-0.259	7.66E-04
ENSG00000132773	TOE1	-0.259	7.24E-04
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ENSG00000165983	PTER	-0.259	4.82E-04
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ENSG00000143442	POGZ	-0.257	6.97E-07
ENSG00000152939	MARVELD2	-0.257	1.86E-05
ENSG00000121067	SPOP	-0.257	7.37E-06
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ENSG00000117222	RBBP5	-0.255	1.19E-05
ENSG00000100150	DEPDC5	-0.255	3.92E-03
ENSG00000152894	PTPRK	-0.255	5.12E-05
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ENSG00000130559	CAMSAP1	-0.255	4.83E-07
ENSG00000027869	SH2D2A	-0.255	4.43E-04
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ENSG00000234545	FAM133B	-0.254	4.81E-04
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ENSG00000179912	R3HDM2	-0.254	5.05E-05
ENSG00000182150	ERCC6L2	-0.254	1.79E-04
ENSG00000023287	RB1CC1	-0.254	9.91E-06
ENSG00000100647	SUSD6	-0.254	3.10E-06
ENSG00000179523	EIF3J-AS1	-0.253	1.27E-02
ENSG00000148516	ZEB1	-0.253	1.90E-03
ENSG00000196792	STRN3	-0.253	1.26E-05
ENSG00000163155	LYSMD1	-0.253	2.72E-02
ENSG00000170581	STAT2	-0.253	2.06E-05
ENSG00000197818	SLC9A8	-0.253	5.19E-06
ENSG00000197568	HHLA3	-0.253	5.59E-03
ENSG00000178966	RMI1	-0.253	1.20E-04
ENSG00000068745	IP6K2	-0.252	2.49E-06
ENSG00000147799	ARHGAP39	-0.252	4.45E-02
ENSG00000100889	PCK2	-0.252	1.92E-04
ENSG00000146587	RBAK	-0.252	6.10E-05
ENSG00000137760	ALKBH8	-0.252	9.00E-04
ENSG00000186566	GPATCH8	-0.252	1.51E-07
ENSG00000135482	ZC3H10	-0.252	4.56E-02
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ENSG00000115661	STK16	-0.250	1.53E-04
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ENSG00000198517	MAFK	-0.250	3.75E-05
ENSG00000140382	HMG20A	-0.250	4.58E-05
ENSG00000104221	BRF2	-0.250	7.81E-03
ENSG00000163848	ZNF148	-0.250	2.42E-06
ENSG00000166272	WBP1L	-0.249	6.30E-06
ENSG00000185246	PRPF39	-0.249	4.01E-04

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ENSG00000112234	FBXL4	-0.249	2.08E-03
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ENSG00000147316	MCPH1	-0.248	8.79E-06
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ENSG00000109220	CHIC2	-0.248	1.24E-03
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ENSG00000079435	LIPE	-0.247	4.94E-03
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ENSG00000188313	PLSCR1	-0.247	8.26E-05
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ENSG00000215190	LINC00680	-0.246	3.59E-02
ENSG00000168497	SDPR	-0.246	8.79E-03
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ENSG00000196653	ZNF502	-0.246	4.57E-02
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ENSG00000087245	MMP2	-0.243	2.10E-03
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ENSG00000173209	AHSA2	-0.241	1.28E-03
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ENSG00000134744	ZCCHC11	-0.240	1.00E-05
ENSG00000150995	ITPR1	-0.240	2.72E-03
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ENSG00000154920	EME1	-0.240	3.18E-03
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ENSG00000165275	TRMT10B	-0.239	1.54E-02
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ENSG00000249673	NOP14-AS1	-0.239	4.25E-04
ENSG00000125967	NECAB3	-0.239	3.19E-02

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ENSG00000121281	ADCY7	-0.238	6.57E-04
ENSG00000007545	CRAMP1	-0.238	5.31E-03
ENSG00000197302	ZNF720	-0.238	1.42E-02
ENSG00000158296	SLC13A3	-0.238	5.25E-03
ENSG00000164066	INTU	-0.238	3.78E-03
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ENSG00000147642	SYBU	-0.237	2.97E-02
ENSG00000104856	RELB	-0.237	1.56E-03
ENSG00000148842	CNNM2	-0.237	1.64E-02
ENSG00000170802	FOXN2	-0.237	1.96E-03
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ENSG00000101966	XIAP	-0.236	2.05E-05
ENSG00000156876	SASS6	-0.235	8.87E-04
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ENSG00000125398	SOX9	-0.235	7.26E-04
ENSG00000166912	MTMR10	-0.235	3.88E-04
ENSG00000165512	ZNF22	-0.235	8.00E-04
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ENSG00000116095	PLEKHA3	-0.233	2.27E-03
ENSG00000204177	BMS1P1	-0.233	1.84E-02
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ENSG00000213859	KCTD11	-0.233	4.02E-05
ENSG00000121406	ZNF549	-0.233	3.49E-02
ENSG00000168876	ANKRD49	-0.233	1.39E-02
ENSG00000166848	TERF2IP	-0.233	2.83E-05
ENSG00000275111	ZNF2	-0.233	3.18E-02

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ENSG00000130940	CASZ1	-0.232	5.52E-03
ENSG00000162236	STX5	-0.232	2.45E-04
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ENSG00000153317	ASAP1	-0.232	5.40E-07
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ENSG00000111249	CUX2	-0.231	2.02E-04
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ENSG00000160051	IQCC	-0.231	1.18E-02
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ENSG00000116539	ASH1L	-0.231	1.22E-06
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ENSG00000198815	FOXJ3	-0.228	2.43E-06
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ENSG00000075240	GRAMD4	-0.227	3.31E-02
ENSG00000137776	SLTM	-0.227	3.50E-07
ENSG00000133739	LRRCC1	-0.227	5.06E-03
ENSG00000107036	RIC1	-0.227	5.17E-05
ENSG00000123415	SMUG1	-0.227	1.06E-02
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ENSG00000173545	ZNF622	-0.226	1.22E-04
ENSG00000198799	LRIG2	-0.226	5.02E-04
ENSG00000171943	SRGAP2C	-0.226	3.03E-03
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ENSG00000094975	SUCO	-0.224	3.12E-04
ENSG00000145819	ARHGAP26	-0.224	9.05E-04
ENSG00000080802	CNOT4	-0.224	1.13E-05
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ENSG00000214517	PPME1	-0.223	7.62E-06
ENSG00000177045	SIX5	-0.223	2.07E-04
ENSG00000255717	SNHG1	-0.223	4.50E-05
ENSG00000137266	SLC22A23	-0.223	8.49E-05
ENSG00000181938	GINS3	-0.223	5.61E-04
ENSG00000100461	RBM23	-0.223	7.26E-06
ENSG00000116580	GON4L	-0.223	1.92E-05
ENSG00000085382	HACE1	-0.222	8.62E-03
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ENSG00000149679	CABLES2	-0.221	3.25E-03
ENSG00000135114	OASL	-0.221	3.25E-04
ENSG00000133059	DSTYK	-0.221	3.88E-04
ENSG00000136205	TNS3	-0.221	1.39E-05
ENSG00000147439	BIN3	-0.221	1.33E-03
ENSG00000128563	PRKRIP1	-0.221	2.70E-04
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ENSG00000171608	PIK3CD	-0.220	1.96E-03
ENSG00000179119	SPTY2D1	-0.220	2.63E-05
ENSG00000155621	C9orf85	-0.220	5.36E-03
ENSG00000278540	ACACA	-0.220	6.14E-07
ENSG00000196417	ZNF765	-0.220	1.60E-02
ENSG00000144824	PHLDB2	-0.220	1.09E-05

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ENSG00000196470	SIAH1	-0.219	5.71E-03
ENSG00000109920	FNBP4	-0.219	3.98E-06
ENSG00000174705	SH3PXD2B	-0.219	1.60E-06
ENSG00000187189	TSPYL4	-0.219	3.59E-04
ENSG00000224660	SH3BP5-AS1	-0.219	4.59E-02
ENSG00000169410	PTPN9	-0.219	5.44E-05
ENSG00000008083	JARID2	-0.218	6.62E-06
ENSG00000198646	NCOA6	-0.218	1.90E-06
ENSG00000102221	JADE3	-0.218	5.14E-03
ENSG00000185507	IRF7	-0.218	8.16E-03
ENSG00000187535	IFT140	-0.218	3.38E-02
ENSG00000164751	PEX2	-0.217	3.37E-03
ENSG00000108469	RECQL5	-0.217	1.75E-04
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ENSG00000144645	OSBPL10	-0.217	7.31E-05
ENSG00000186073	C15orf41	-0.217	4.43E-03
ENSG00000135378	PRRG4	-0.217	1.90E-04
ENSG00000136098	NEK3	-0.216	6.02E-03
ENSG00000198142	SOWAHC	-0.216	1.78E-05
ENSG00000197256	KANK2	-0.216	9.99E-05
ENSG00000119772	DNMT3A	-0.216	5.34E-03
ENSG00000198478	SH3BGRL2	-0.215	3.09E-02
ENSG00000141448	GATA6	-0.215	2.07E-03
ENSG00000155906	RMND1	-0.214	8.36E-03
ENSG00000070778	PTPN21	-0.214	1.24E-03
ENSG00000175595	ERCC4	-0.214	2.72E-03
ENSG00000185436	IFNLR1	-0.214	1.08E-02
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ENSG00000105053	VRK3	-0.214	5.72E-03
ENSG00000166261	ZNF202	-0.214	5.78E-03
ENSG00000180543	TSPYL5	-0.214	9.18E-04
ENSG00000109971	HSPA8	-0.213	7.11E-08
ENSG00000204217	BMPR2	-0.213	7.59E-05
ENSG00000188554	NBR1	-0.213	5.61E-06
ENSG00000089123	TASP1	-0.213	2.79E-02
ENSG00000143622	RIT1	-0.213	4.57E-04
ENSG00000187800	PEAR1	-0.213	3.20E-02
ENSG00000137221	TJAP1	-0.213	8.41E-04
ENSG00000130299	GTPBP3	-0.213	7.65E-04

ENSG00000164327	RICTOR	-0.213	9.93E-05
ENSG00000094841	UPRT	-0.213	2.27E-02
ENSG00000164830	OXR1	-0.212	1.97E-04
ENSG00000125885	MCM8	-0.212	1.47E-05
ENSG00000176046	NUPR1	-0.212	1.79E-03
ENSG00000118689	FOXO3	-0.212	5.67E-06
ENSG00000140563	MCTP2	-0.212	6.17E-03
ENSG00000198920	KIAA0753	-0.212	1.64E-03
ENSG00000077782	FGFR1	-0.211	7.25E-04
ENSG00000095794	CREM	-0.211	3.65E-02
ENSG00000048707	VPS13D	-0.211	1.89E-05
ENSG00000164068	RNF123	-0.211	7.91E-04
ENSG00000131697	NPHP4	-0.211	7.41E-03
ENSG00000144711	IQSEC1	-0.211	2.95E-03
ENSG00000105662	CRTC1	-0.211	2.92E-02
ENSG00000171105	INSR	-0.211	2.13E-02
ENSG00000160360	GPSM1	-0.210	1.55E-02
ENSG00000108587	GOSR1	-0.210	1.50E-05
ENSG00000089234	BRAP	-0.210	1.03E-04
ENSG00000006652	IFRD1	-0.210	1.87E-05
ENSG00000165813	CCDC186	-0.210	8.92E-04
ENSG00000006756	ARSD	-0.209	2.42E-02
ENSG00000111554	MDM1	-0.209	1.41E-02
ENSG00000221926	TRIM16	-0.209	1.22E-02
ENSG00000117226	GBP3	-0.209	1.52E-03
ENSG00000119711	ALDH6A1	-0.209	3.22E-02
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ENSG00000129518	EAPP	-0.203	4.24E-04
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ENSG00000155508	CNOT8	-0.166	1.43E-03
ENSG00000172432	GTPBP2	-0.166	3.61E-04
ENSG00000131013	PPIL4	-0.166	7.06E-03
ENSG00000070366	SMG6	-0.166	1.33E-03
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ENSG00000135845	PIGC	-0.166	3.07E-02
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ENSG00000110723	EXPH5	-0.164	3.92E-02
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ENSG00000225830	ERCC6	-0.163	1.62E-02
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ENSG00000104946	TBC1D17	-0.163	2.33E-02
ENSG00000126870	WDR60	-0.163	1.30E-02
ENSG00000211455	STK38L	-0.163	5.19E-04
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ENSG00000101190	TCFL5	-0.162	7.46E-03

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ENSG00000162642	C1orf52	-0.162	3.22E-02
ENSG00000079691	LRRC16A	-0.162	2.49E-03
ENSG00000100105	PATZ1	-0.162	1.18E-02
ENSG00000164045	CDC25A	-0.162	2.12E-03
ENSG00000280798	LINC00294	-0.162	4.89E-02
ENSG00000183718	TRIM52	-0.161	2.77E-02
ENSG00000100124	ANKRD54	-0.161	2.70E-02
ENSG00000132740	IGHMBP2	-0.161	2.07E-02
ENSG00000055917	PUM2	-0.161	5.28E-04
ENSG00000185946	RNPC3	-0.161	4.22E-02
ENSG00000132466	ANKRD17	-0.161	2.57E-05
ENSG00000188636	LDOC1L	-0.160	3.29E-03
ENSG00000124151	NCOA3	-0.160	2.72E-05
ENSG00000067606	PRKCZ	-0.160	1.76E-02
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ENSG00000165494	PCF11	-0.160	1.44E-04
ENSG00000135093	USP30	-0.159	4.91E-02
ENSG00000088970	KIZ	-0.159	2.90E-02
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ENSG00000179151	EDC3	-0.159	1.23E-03
ENSG00000198876	DCAF12	-0.159	3.55E-04
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ENSG00000103248	MTHFSD	-0.158	2.82E-02
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ENSG00000204231	RXRB	-0.158	7.96E-03
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ENSG00000111817	DSE	-0.157	1.43E-04
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ENSG00000181827	RFX7	-0.156	7.95E-04
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ENSG00000196850	PPTC7	-0.154	7.85E-04
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ENSG00000076685	NT5C2	-0.154	2.46E-03
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ENSG00000138592	USP8	-0.151	7.35E-04

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ENSG00000165675	ENOX2	-0.150	2.52E-02
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ENSG00000168806	LCMT2	-0.148	2.26E-02
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ENSG00000137203	TFAP2A	-0.145	2.74E-03
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ENSG00000133687	TMTC1	-0.144	7.74E-04
ENSG00000133872	SARAF	-0.144	9.43E-04
ENSG00000164970	FAM219A	-0.144	3.22E-02
ENSG00000113645	WWC1	-0.144	1.37E-03
ENSG00000117614	SYF2	-0.144	2.34E-02
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ENSG00000176142	TMEM39A	-0.141	3.40E-02
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ENSG00000109466	KLHL2	-0.140	2.80E-02
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ENSG00000120727	PAIP2	-0.139	8.77E-03

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ENSG00000120889	TNFRSF10B	-0.135	7.93E-04
ENSG00000196367	TRRAP	-0.134	6.41E-03
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ENSG00000162298	SYVN1	-0.132	1.04E-02
ENSG00000148218	ALAD	-0.132	2.57E-02
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ENSG00000168438	CDC40	-0.131	3.12E-02
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ENSG00000159579	RSPRY1	-0.131	2.05E-02
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ENSG00000136144	RCBTB1	-0.131	4.92E-02
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ENSG00000163781	TOPBP1	-0.129	3.33E-03
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ENSG00000169252	ADRB2	-0.128	3.22E-02
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ENSG00000184792	OSBP2	-0.127	2.19E-02
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ENSG00000172216	CEBPB	-0.127	1.97E-02
ENSG00000148606	POLR3A	-0.127	1.24E-02
ENSG00000173064	HECTD4	-0.126	1.81E-02
ENSG00000144736	SHQ1	-0.126	4.66E-02
ENSG00000169499	PLEKHA2	-0.126	2.40E-02
ENSG00000079313	REXO1	-0.126	2.14E-02
ENSG00000106070	GRB10	-0.126	2.31E-02
ENSG00000179335	CLK3	-0.126	1.15E-02
ENSG00000189339	SLC35E2B	-0.126	4.50E-03
ENSG00000076003	MCM6	-0.126	7.36E-03
ENSG00000173542	MOB1B	-0.126	1.14E-02
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ENSG00000134775	FHOD3	-0.126	8.35E-03
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ENSG00000197321	SVIL	-0.125	2.51E-03
ENSG00000136560	TANK	-0.125	1.30E-02
ENSG00000180182	MED14	-0.125	5.14E-03
ENSG00000088808	PPP1R13B	-0.124	3.03E-02
ENSG00000203875	SNHG5	-0.124	3.73E-02
ENSG00000159592	GPBP1L1	-0.124	3.61E-03
ENSG00000175137	SH3BP5L	-0.124	2.18E-02
ENSG00000184349	EFNA5	-0.124	2.66E-02
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ENSG00000103111	MON1B	-0.124	6.21E-03
ENSG00000205885	C1RL-AS1	-0.123	5.02E-02
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ENSG00000115902	SLC1A4	-0.123	1.68E-02
ENSG00000198730	CTR9	-0.123	4.73E-03

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ENSG00000141084	RANBP10	-0.123	1.65E-02
ENSG00000073111	MCM2	-0.123	2.69E-03
ENSG00000004975	DVL2	-0.123	1.27E-02
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ENSG00000068323	TFE3	-0.122	1.54E-02
ENSG00000157625	TAB3	-0.122	2.03E-03
ENSG00000036549	ZZZ3	-0.122	3.03E-03
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ENSG00000157551	KCNJ15	-0.122	3.00E-02
ENSG00000037749	MFAP3	-0.122	2.06E-02
ENSG00000168495	POLR3D	-0.121	2.35E-02
ENSG00000080371	RAB21	-0.121	3.36E-02
ENSG00000138685	FGF2	-0.121	4.51E-02
ENSG00000196083	IL1RAP	-0.121	9.83E-03
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ENSG00000080839	RBL1	-0.120	4.81E-03
ENSG00000127328	RAB3IP	-0.120	5.04E-02
ENSG00000110841	PPFIBP1	-0.120	1.30E-02
ENSG00000123200	ZC3H13	-0.120	1.83E-03
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ENSG00000166887	VPS39	-0.119	9.19E-03
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ENSG00000112033	PPARD	-0.118	1.80E-02
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ENSG00000203880	PCMTD2	-0.118	4.38E-02
ENSG00000141510	TP53	-0.118	6.28E-03
ENSG00000081177	EXD2	-0.118	4.20E-02
ENSG00000139505	MTMR6	-0.118	1.58E-02
ENSG00000091651	ORC6	-0.118	3.87E-02
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ENSG00000118454	ANKRD13C	-0.118	1.98E-02
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ENSG00000119969	HELLS	-0.118	3.19E-02
ENSG00000128607	KLHDC10	-0.118	2.07E-02
ENSG00000115414	FN1	-0.118	4.46E-02

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ENSG00000119138	KLF9	-0.117	2.65E-02
ENSG00000165219	GAPVD1	-0.117	3.27E-03
ENSG00000164294	GPX8	-0.117	2.47E-02
ENSG00000128283	CDC42EP1	-0.116	1.74E-02
ENSG00000100023	PPIL2	-0.116	8.74E-03
ENSG00000168175	MAPK1IP1L	-0.116	1.16E-02
ENSG00000131746	TNS4	-0.116	2.17E-03
ENSG00000111424	VDR	-0.115	2.24E-03
ENSG00000102870	ZNF629	-0.115	2.55E-02
ENSG00000197381	ADARB1	-0.115	3.39E-02
ENSG00000134371	CDC73	-0.115	1.61E-02
ENSG00000160299	PCNT	-0.115	1.86E-02
ENSG00000108395	TRIM37	-0.115	3.47E-02
ENSG00000081014	AP4E1	-0.115	4.49E-02
ENSG00000133216	EPHB2	-0.115	4.39E-02
ENSG00000165905	GYLTL1B	-0.115	3.59E-02
ENSG00000103404	USP31	-0.115	2.71E-02
ENSG00000128923	FAM63B	-0.114	3.01E-02
ENSG00000114331	ACAP2	-0.114	2.86E-02
ENSG00000056586	RC3H2	-0.114	5.35E-03
ENSG00000139496	NUP58	-0.114	6.15E-03
ENSG00000196756	SNHG17	-0.114	2.94E-02
ENSG00000142784	WDTC1	-0.113	1.27E-02
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ENSG00000085832	EPS15	-0.112	4.95E-02
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ENSG00000151208	DLG5	-0.112	6.09E-03
ENSG00000205726	ITSN1	-0.112	1.01E-02
ENSG00000095787	WAC	-0.111	1.27E-03
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ENSG00000141446	ESCO1	-0.111	3.91E-02
ENSG00000185591	SP1	-0.110	4.01E-03

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ENSG00000008441	NFIX	-0.110	4.32E-02
ENSG00000148498	PARD3	-0.110	1.26E-02
ENSG00000155545	MIER3	-0.110	2.37E-02
ENSG00000138614	VWA9	-0.110	3.69E-02
ENSG00000169826	CSGALNACT2	-0.109	4.77E-02
ENSG00000116001	TIA1	-0.109	3.43E-02
ENSG00000181555	SETD2	-0.109	3.17E-03
ENSG00000124486	USP9X	-0.109	8.36E-03
ENSG00000165006	UBAP1	-0.109	8.15E-03
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ENSG00000070018	LRP6	-0.108	2.03E-02
ENSG00000140718	FTO	-0.108	4.22E-02
ENSG00000125686	MED1	-0.108	3.53E-03
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ENSG00000123983	ACSL3	-0.107	4.67E-03
ENSG00000079432	CIC	-0.107	3.16E-02
ENSG00000129292	PHF20L1	-0.107	1.80E-02
ENSG00000055208	TAB2	-0.107	4.70E-03
ENSG00000135457	TFCP2	-0.107	2.35E-02
ENSG00000132824	SERINC3	-0.107	8.02E-03
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ENSG00000124198	ARFGEF2	-0.106	4.54E-03
ENSG00000076242	MLH1	-0.106	2.10E-02
ENSG00000197343	ZNF655	-0.106	4.08E-02
ENSG00000049239	H6PD	-0.106	4.61E-02
ENSG00000157985	AGAP1	-0.105	3.32E-02
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ENSG00000213079	SCAF8	-0.103	1.60E-02
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ENSG00000170471	RALGAPB	-0.103	3.73E-03
ENSG00000120451	SNX19	-0.103	1.75E-02
ENSG00000185619	PCGF3	-0.103	2.05E-02
ENSG00000121058	COIL	-0.103	4.88E-02

ENSG00000110619	CARS	-0.103	1.72E-02
ENSG00000102189	EEA1	-0.102	3.42E-02
ENSG00000168256	NKIRAS2	-0.102	2.67E-02
ENSG00000067596	DHX8	-0.102	2.78E-02
ENSG00000099940	SNAP29	-0.102	2.48E-02
ENSG00000160551	TAOK1	-0.101	8.86E-03
ENSG00000197122	SRC	-0.101	3.58E-02
ENSG00000179134	SAMD4B	-0.101	8.80E-03
ENSG00000128731	HERC2	-0.101	3.42E-02
ENSG00000112983	BRD8	-0.100	1.24E-02
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ENSG00000157540	DYRK1A	-0.100	4.03E-02
ENSG00000083444	PLOD1	-0.100	1.28E-02
ENSG00000171634	BPTF	-0.100	4.84E-03
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ENSG00000110330	BIRC2	-0.099	3.86E-02
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ENSG00000149532	CPSF7	-0.097	7.31E-03
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ENSG00000169967	MAP3K2	-0.097	4.82E-02
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ENSG00000115464	USP34	-0.096	1.45E-02
ENSG00000006327	TNFRSF12A	-0.096	2.98E-02
ENSG00000182199	SHMT2	-0.096	1.75E-02
ENSG00000129933	MAU2	-0.095	3.36E-02
ENSG00000154305	MIA3	-0.095	2.02E-02
ENSG00000122257	RBBP6	-0.095	1.14E-02
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ENSG00000138398	PPIG	-0.094	2.83E-02
ENSG00000214078	CPNE1	-0.094	3.17E-02
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ENSG00000146457	WTAP	-0.093	2.61E-02
ENSG00000119760	SUPT7L	-0.093	4.64E-02

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ENSG00000169045	HNRNPH1	-0.091	8.07E-03
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ENSG00000109686	SH3D19	-0.090	3.91E-02
ENSG00000092203	TOX4	-0.089	2.37E-02
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ENSG00000167110	GOLGA2	-0.088	3.73E-02
ENSG00000070159	PTPN3	-0.088	3.25E-02
ENSG00000160293	VAV2	-0.088	4.07E-02
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ENSG00000158545	ZC3H18	-0.085	4.20E-02
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ENSG00000072803	FBXW11	-0.084	4.14E-02
ENSG00000147394	ZNF185	-0.084	4.38E-02
ENSG00000075151	EIF4G3	-0.083	2.09E-02
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ENSG00000137337	MDC1	-0.080	3.84E-02
ENSG00000166340	TPP1	-0.080	3.91E-02
ENSG00000189266	PNRC2	-0.078	4.46E-02
ENSG00000103994	ZNF106	-0.077	3.56E-02
ENSG00000104635	SLC39A14	-0.076	4.57E-02
ENSG00000084112	SSH1	-0.076	3.68E-02
ENSG00000114439	BBX	-0.071	5.07E-02
ENSG00000089597	GANAB	0.062	4.47E-02
ENSG00000076108	BAZ2A	0.065	4.83E-02
ENSG00000092199	HNRNPC	0.066	3.00E-02
ENSG00000087365	SF3B2	0.068	3.39E-02
ENSG00000173473	SMARCC1	0.070	3.23E-02
ENSG00000161016	RPL8	0.071	3.17E-02

ENSG00000089159	PXN	0.071	3.96E-02
ENSG00000142534	RPS11	0.071	2.22E-02
ENSG00000111640	GAPDH	0.072	2.51E-02
ENSG00000196305	IARS	0.072	2.31E-02
ENSG00000145623	OSMR	0.073	3.54E-02
ENSG00000101150	TPD52L2	0.073	3.17E-02
ENSG00000116688	MFN2	0.074	3.69E-02
ENSG00000137076	TLN1	0.074	4.50E-02
ENSG00000138674	SEC31A	0.074	4.44E-02
ENSG00000160691	SHC1	0.075	2.10E-02
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ENSG00000101421	CHMP4B	0.076	4.21E-02
ENSG00000135506	OS9	0.076	3.83E-02
ENSG00000084234	APLP2	0.076	1.57E-02
ENSG00000111144	LTA4H	0.076	4.38E-02
ENSG00000130175	PRKCSH	0.077	3.33E-02
ENSG00000184292	TACSTD2	0.077	3.68E-02
ENSG00000105976	MET	0.077	2.30E-02
ENSG00000173402	DAG1	0.077	4.09E-02
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ENSG00000084207	GSTP1	0.077	4.24E-02
ENSG00000113648	H2AFY	0.078	1.57E-02
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ENSG00000088930	XRN2	0.078	3.45E-02
ENSG00000104824	HNRNPL	0.079	2.97E-02
ENSG00000185963	BICD2	0.079	3.77E-02
ENSG00000068438	FTSJ1	0.079	4.43E-02
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ENSG00000157483	MYO1E	0.080	3.11E-02
ENSG00000178035	IMPDH2	0.080	3.55E-02
ENSG00000126524	SBDS	0.080	4.29E-02
ENSG00000156482	RPL30	0.081	1.37E-02
ENSG00000167986	DDB1	0.081	1.83E-02
ENSG00000113658	SMAD5	0.081	4.65E-02
ENSG00000182087	TMEM259	0.081	4.09E-02
ENSG00000196419	XRCC6	0.081	2.13E-02
ENSG00000134697	GNL2	0.081	3.88E-02
ENSG00000172270	BSG	0.081	3.59E-02
ENSG00000162521	RBBP4	0.082	3.59E-02
ENSG00000133835	HSD17B4	0.082	4.28E-02
ENSG00000113719	ERGIC1	0.082	1.64E-02
ENSG00000113583	C5orf15	0.082	2.53E-02

ENSG00000127483	HP1BP3	0.082	2.76E-02
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ENSG00000133030	MPRIP	0.083	2.78E-02
ENSG00000069956	MAPK6	0.083	4.31E-02
ENSG00000123416	TUBA1B	0.083	4.83E-02
ENSG00000124562	SNRPC	0.083	3.86E-02
ENSG00000168028	RPSA	0.083	9.21E-03
ENSG00000149273	RPS3	0.084	1.46E-02
ENSG00000135624	CCT7	0.084	1.45E-02
ENSG00000162244	RPL29	0.084	2.22E-02
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ENSG00000108828	VAT1	0.084	4.16E-02
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ENSG00000124214	STAU1	0.084	1.07E-02
ENSG00000136813	KIAA0368	0.084	1.65E-02
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ENSG00000198034	RPS4X	0.084	5.39E-03
ENSG00000138768	USO1	0.084	4.08E-02
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ENSG00000126247	CAPNS1	0.085	2.54E-02
ENSG00000145391	SETD7	0.085	3.25E-02
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ENSG00000108518	PFN1	0.085	3.42E-02
ENSG00000066322	ELOVL1	0.085	4.80E-02
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ENSG00000124831	LRRFIP1	0.086	1.07E-02
ENSG00000142676	RPL11	0.086	4.97E-03
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ENSG00000004142	POLDIP2	0.087	4.01E-02
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ENSG00000091164	TXNL1	0.087	4.09E-02
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ENSG00000102572	STK24	0.087	1.15E-02
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ENSG00000127022	CANX	0.088	3.47E-02
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ENSG00000131504	DIAPH1	0.088	7.71E-03

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ENSG00000164828	SUN1	0.088	1.86E-02
ENSG00000160285	LSS	0.088	4.19E-02
ENSG00000141551	CSNK1D	0.089	1.15E-02
ENSG00000130520	LSM4	0.089	4.65E-02
ENSG00000023228	NDUFS1	0.089	2.46E-02
ENSG00000169032	MAP2K1	0.089	3.77E-02
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ENSG00000141959	PFKL	0.089	4.46E-02
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ENSG00000149657	LSM14B	0.090	4.86E-02
ENSG00000174903	RAB1B	0.090	2.03E-02
ENSG00000127837	AAMP	0.090	4.20E-02
ENSG00000111057	KRT18	0.090	5.03E-02
ENSG00000114942	EEF1B2	0.090	1.20E-02
ENSG00000130066	SAT1	0.090	1.99E-02
ENSG00000156515	HK1	0.090	1.91E-02
ENSG00000138757	G3BP2	0.090	1.06E-02
ENSG00000132646	PCNA	0.091	7.34E-03
ENSG00000124795	DEK	0.091	2.49E-02
ENSG00000147853	AK3	0.091	3.08E-02
ENSG00000115307	AUP1	0.091	3.54E-02
ENSG00000196754	S100A2	0.091	3.07E-02
ENSG00000204209	DAXX	0.091	4.82E-02
ENSG00000147475	ERLIN2	0.091	4.87E-02
ENSG00000113013	HSPA9	0.091	8.07E-03
ENSG00000165637	VDAC2	0.091	1.51E-02
ENSG00000125818	PSMF1	0.091	1.08E-02
ENSG00000100462	PRMT5	0.091	9.60E-03
ENSG00000123349	PFDN5	0.092	3.31E-02
ENSG00000112473	SLC39A7	0.092	1.28E-02
ENSG00000143153	ATP1B1	0.092	4.22E-02
ENSG00000189241	TSPYL1	0.092	1.67E-02
ENSG00000275700	AATF	0.092	2.93E-02
ENSG00000142192	APP	0.092	3.26E-03
ENSG00000071553	ATP6AP1	0.092	4.51E-02
ENSG00000205420	KRT6A	0.092	2.06E-02
ENSG00000010256	UQCRC1	0.092	3.18E-02
ENSG00000174437	ATP2A2	0.092	2.73E-03

ENSG00000101160	CTSZ	0.092	1.13E-02
ENSG00000221983	UBA52	0.092	3.54E-02
ENSG00000156875	HIAT1	0.092	3.26E-02
ENSG00000136699	SMPD4	0.092	1.32E-02
ENSG00000110660	SLC35F2	0.092	4.13E-02
ENSG00000115875	SRSF7	0.093	1.66E-02
ENSG00000183431	SF3A3	0.093	8.42E-03
ENSG00000122203	KIAA1191	0.093	1.69E-02
ENSG00000087460	GNAS	0.093	2.58E-03
ENSG00000183255	PTTG1IP	0.093	1.16E-02
ENSG00000070010	UFD1L	0.093	3.61E-02
ENSG00000168496	FEN1	0.093	2.22E-02
ENSG00000178982	EIF3K	0.093	1.51E-02
ENSG00000100030	MAPK1	0.093	1.52E-02
ENSG00000164902	PHAX	0.093	2.22E-02
ENSG00000108100	CCNY	0.093	3.09E-02
ENSG00000185624	P4HB	0.093	1.54E-02
ENSG00000079246	XRCC5	0.093	4.09E-03
ENSG00000165916	PSMC3	0.093	3.83E-02
ENSG00000132405	TBC1D14	0.094	4.92E-02
ENSG00000197958	RPL12	0.094	4.28E-03
ENSG00000025800	KPNA6	0.094	2.13E-02
ENSG00000142166	IFNAR1	0.094	4.87E-02
ENSG00000158435	CNOT11	0.094	3.59E-02
ENSG00000132305	IMMT	0.094	7.97E-03
ENSG00000173744	AGFG1	0.094	3.98E-02
ENSG00000106615	RHEB	0.094	2.17E-02
ENSG00000196504	PRPF40A	0.094	2.03E-02
ENSG00000111319	SCNN1A	0.094	8.49E-03
ENSG00000123562	MORF4L2	0.095	1.33E-02
ENSG00000213024	NUP62	0.095	2.08E-02
ENSG00000133706	LARS	0.095	1.18E-02
ENSG00000110107	PRPF19	0.095	2.07E-02
ENSG00000105438	KDELR1	0.095	2.50E-02
ENSG00000179295	PTPN11	0.096	7.23E-03
ENSG00000114738	MAPKAPK3	0.096	4.83E-02
ENSG00000180370	PAK2	0.096	2.18E-02
ENSG00000165175	MID1IP1	0.096	3.77E-02
ENSG00000148358	GPR107	0.096	1.50E-02
ENSG00000130414	NDUFA10	0.096	4.20E-02
ENSG00000090686	USP48	0.096	4.31E-02
ENSG00000142208	AKT1	0.096	8.72E-03
ENSG00000131844	MCCC2	0.096	1.56E-02

ENSG00000007168	PAFAH1B1	0.096	1.39E-02
ENSG00000091542	ALKBH5	0.096	4.16E-02
ENSG00000133318	RTN3	0.097	1.38E-02
ENSG00000161057	PSMC2	0.097	1.31E-02
ENSG00000156110	ADK	0.097	3.96E-02
ENSG00000164091	WDR82	0.097	9.13E-03
ENSG00000159461	AMFR	0.098	3.35E-02
ENSG00000061676	NCKAP1	0.098	2.48E-02
ENSG00000168710	AHCYL1	0.098	1.20E-02
ENSG00000161217	PCYT1A	0.098	2.48E-02
ENSG00000108179	PPIF	0.098	1.36E-02
ENSG00000166226	CCT2	0.098	1.10E-02
ENSG00000131711	MAP1B	0.098	2.39E-02
ENSG00000170017	ALCAM	0.098	9.78E-03
ENSG00000140105	WARS	0.098	7.40E-03
ENSG00000100029	PES1	0.098	1.03E-02
ENSG00000111667	USP5	0.098	3.23E-02
ENSG00000188706	ZDHHC9	0.098	4.11E-02
ENSG00000133226	SRRM1	0.098	9.45E-03
ENSG00000070756	PABPC1	0.098	2.14E-03
ENSG00000068654	POLR1A	0.098	1.86E-02
ENSG00000116478	HDAC1	0.098	2.10E-02
ENSG00000125870	SNRPB2	0.098	2.51E-02
ENSG00000002586	CD99	0.099	2.55E-02
ENSG00000091409	ITGA6	0.099	4.00E-03
ENSG00000011426	ANLN	0.099	4.59E-03
ENSG00000152332	UHMK1	0.099	3.41E-02
ENSG00000087274	ADD1	0.099	6.54E-03
ENSG00000100714	MTHFD1	0.099	8.36E-03
ENSG00000010292	NCAPD2	0.099	9.80E-03
ENSG00000114353	GNAI2	0.099	2.31E-02
ENSG00000101266	CSNK2A1	0.099	4.63E-03
ENSG00000176087	SLC35A4	0.099	1.92E-02
ENSG00000072571	HMMR	0.099	4.75E-02
ENSG00000131873	CHSY1	0.099	2.93E-02
ENSG00000146242	TPBG	0.100	1.48E-02
ENSG00000168036	CTNNB1	0.100	6.34E-03
ENSG00000174547	MRPL11	0.100	3.46E-02
ENSG00000079739	PGM1	0.100	3.03E-02
ENSG00000165684	SNAPC4	0.100	4.79E-02
ENSG00000006125	AP2B1	0.100	3.16E-03
ENSG00000103064	SLC7A6	0.100	3.47E-02
ENSG00000087263	OGFOD1	0.100	1.49E-02

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ENSG00000065150	IPO5	0.100	8.23E-03
ENSG00000096433	ITPR3	0.100	9.74E-03
ENSG00000175390	EIF3F	0.101	6.57E-03
ENSG00000109171	SLAIN2	0.101	1.67E-02
ENSG00000145604	SKP2	0.101	3.67E-02
ENSG00000178038	ALS2CL	0.101	1.86E-02
ENSG00000138107	ACTR1A	0.101	7.46E-03
ENSG00000104529	EEF1D	0.101	1.08E-02
ENSG00000100911	PSME2	0.101	4.39E-02
ENSG00000005100	DHX33	0.101	1.89E-02
ENSG00000116209	TMEM59	0.101	3.54E-02
ENSG00000135821	GLUL	0.101	5.24E-03
ENSG00000100316	RPL3	0.101	1.40E-03
ENSG00000164024	METAP1	0.101	1.74E-02
ENSG00000164880	INTS1	0.101	2.07E-02
ENSG00000163655	GMPS	0.101	9.94E-03
ENSG00000006607	FARP2	0.101	3.56E-02
ENSG00000126267	COX6B1	0.101	3.14E-02
ENSG00000108468	CBX1	0.101	1.90E-02
ENSG00000185608	MRPL40	0.101	4.57E-02
ENSG00000011007	TCEB3	0.101	5.96E-03
ENSG00000136271	DDX56	0.102	4.95E-02
ENSG00000141574	SECTM1	0.102	4.75E-02
ENSG00000171720	HDAC3	0.102	1.36E-02
ENSG00000169764	UGP2	0.102	1.91E-02
ENSG00000119403	PHF19	0.102	1.80E-02
ENSG00000156711	MAPK13	0.102	3.09E-02
ENSG00000118217	ATF6	0.103	1.22E-02
ENSG00000186468	RPS23	0.103	4.71E-03
ENSG00000187735	TCEA1	0.103	4.22E-02
ENSG00000170275	CRTAP	0.103	4.36E-03
ENSG00000162889	MAPKAPK2	0.103	9.50E-03
ENSG00000198561	CTNND1	0.103	1.79E-03
ENSG00000248527	MTATP6P1	0.103	2.33E-02
ENSG00000046604	DSG2	0.103	3.67E-03
ENSG00000153044	CENPH	0.103	3.69E-02
ENSG00000101158	NELFCD	0.103	1.32E-02
ENSG00000160310	PRMT2	0.103	3.75E-02
ENSG00000133142	TCEAL4	0.103	2.31E-02
ENSG00000171302	CANT1	0.103	4.11E-02
ENSG00000153015	CWC27	0.103	2.88E-02
ENSG00000108639	SYNGR2	0.103	4.20E-02

ENSG00000188976	NOC2L	0.103	6.58E-03
ENSG00000107438	PDLIM1	0.103	9.05E-03
ENSG00000143621	ILF2	0.103	4.41E-03
ENSG00000139644	TMBIM6	0.103	1.15E-03
ENSG00000080608	PUM3	0.103	2.14E-02
ENSG00000142453	CARM1	0.103	4.00E-02
ENSG00000104331	IMPAD1	0.104	9.77E-03
ENSG00000157106	SMG1	0.104	1.26E-02
ENSG00000140521	POLG	0.104	2.79E-02
ENSG00000075856	SART3	0.104	1.66E-02
ENSG00000161203	AP2M1	0.104	7.22E-03
ENSG00000112742	TTK	0.104	2.08E-02
ENSG00000106682	EIF4H	0.104	2.39E-03
ENSG00000138594	TMOD3	0.104	1.84E-02
ENSG00000131469	RPL27	0.104	1.10E-02
ENSG00000126777	KTN1	0.104	8.74E-03
ENSG00000162191	UBXN1	0.104	1.01E-02
ENSG00000073060	SCARB1	0.104	1.18E-02
ENSG00000137818	RPLP1	0.104	4.51E-02
ENSG00000083312	TNPO1	0.104	5.17E-03
ENSG00000074695	LMAN1	0.104	9.25E-03
ENSG00000076706	MCAM	0.104	4.09E-03
ENSG00000144043	TEX261	0.105	1.39E-02
ENSG00000078618	NRD1	0.105	4.12E-03
ENSG00000175193	PARL	0.105	4.18E-02
ENSG00000128422	KRT17	0.105	1.57E-03
ENSG00000120256	LRP11	0.105	3.61E-02
ENSG00000115816	CEBPZ	0.105	3.26E-02
ENSG00000179051	RCC2	0.105	1.64E-03
ENSG00000024422	EHD2	0.105	1.10E-02
ENSG00000108349	CASC3	0.105	7.64E-03
ENSG00000164164	OTUD4	0.105	9.66E-03
ENSG00000138430	OLA1	0.105	1.35E-02
ENSG00000106853	PTGR1	0.105	4.28E-02
ENSG00000136930	PSMB7	0.105	6.97E-03
ENSG00000099817	POLR2E	0.105	4.09E-02
ENSG00000114302	PRKAR2A	0.105	1.34E-02
ENSG00000005194	CIAPIN1	0.106	3.01E-02
ENSG00000132383	RPA1	0.106	4.71E-03
ENSG00000134291	TMEM106C	0.106	3.46E-02
ENSG00000105323	HNRNPUL1	0.106	2.48E-03
ENSG00000198755	RPL10A	0.106	1.48E-03
ENSG00000206053	HN1L	0.106	3.23E-03

ENSG00000044115	CTNNA1	0.106	1.21E-03
ENSG00000139433	GLTP	0.106	4.56E-02
ENSG00000144744	UBA3	0.106	2.61E-02
ENSG00000166033	HTRA1	0.106	8.41E-03
ENSG00000173156	RHOD	0.106	4.58E-02
ENSG00000127314	RAP1B	0.106	1.02E-02
ENSG00000166266	CUL5	0.106	3.31E-02
ENSG00000177963	RIC8A	0.106	1.24E-02
ENSG00000164904	ALDH7A1	0.106	7.12E-03
ENSG00000107566	ERLIN1	0.106	1.78E-02
ENSG00000103005	USB1	0.107	1.63E-02
ENSG00000142207	URB1	0.107	6.96E-03
ENSG00000198712	MT-CO2	0.107	3.05E-03
ENSG00000085998	POMGNT1	0.107	2.24E-02
ENSG00000164292	RHOBTB3	0.107	2.03E-02
ENSG00000079999	KEAP1	0.107	3.74E-02
ENSG00000143222	UFC1	0.107	4.49E-02
ENSG00000067225	PKM	0.107	1.05E-03
ENSG00000179115	FARSA	0.107	2.87E-02
ENSG00000148688	RPP30	0.107	2.99E-02
ENSG00000104853	CLPTM1	0.107	1.21E-02
ENSG00000158526	TSR2	0.108	4.03E-02
ENSG00000065526	SPEN	0.108	5.09E-03
ENSG00000178921	PFAS	0.108	2.40E-02
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ENSG00000205937	RNPS1	0.108	6.31E-03
ENSG00000138668	HNRNPD	0.108	4.48E-03
ENSG00000109519	GRPEL1	0.108	2.85E-02
ENSG00000178202	KDELC2	0.108	2.36E-02
ENSG00000122642	FKBP9	0.108	1.88E-02
ENSG00000157020	SEC13	0.108	1.53E-02
ENSG00000170445	HARS	0.108	8.01E-03
ENSG00000149639	SOGA1	0.108	1.04E-02
ENSG00000125484	GTF3C4	0.108	1.04E-02
ENSG00000059573	ALDH18A1	0.108	2.31E-02
ENSG00000142089	IFITM3	0.108	4.83E-03
ENSG00000105928	DFNA5	0.108	1.23E-02
ENSG00000159658	EFCAB14	0.108	6.86E-03
ENSG00000089063	TMEM230	0.108	7.34E-03
ENSG00000123472	ATPAF1	0.109	3.69E-02
ENSG00000043143	JADE2	0.109	6.35E-03
ENSG00000102007	PLP2	0.109	8.94E-03
ENSG00000100994	PYGB	0.109	3.07E-03

ENSG00000164916	FOXK1	0.109	4.87E-02
ENSG00000176171	BNIP3	0.109	1.32E-02
ENSG00000175792	RUVBL1	0.109	1.79E-02
ENSG00000165527	ARF6	0.109	2.00E-03
ENSG00000178719	GRINA	0.109	1.54E-02
ENSG00000137699	TRIM29	0.109	9.19E-03
ENSG00000159322	ADPGK	0.109	4.57E-02
ENSG00000076928	ARHGEF1	0.109	1.77E-02
ENSG00000158941	CCAR2	0.109	5.17E-03
ENSG00000124164	VAPB	0.110	4.74E-03
ENSG00000120896	SORBS3	0.110	4.09E-02
ENSG00000169100	SLC25A6	0.110	9.89E-03
ENSG00000004487	KDM1A	0.110	6.71E-03
ENSG00000142507	PSMB6	0.110	1.75E-02
ENSG00000104852	SNRNP70	0.110	2.88E-03
ENSG00000111481	COPZ1	0.110	1.47E-02
ENSG00000008018	PSMB1	0.110	1.43E-02
ENSG00000130770	ATPIF1	0.110	1.11E-02
ENSG00000134779	TPGS2	0.110	6.79E-03
ENSG00000203485	INF2	0.110	2.35E-02
ENSG00000103479	RBL2	0.110	1.37E-02
ENSG00000182944	EWSR1	0.110	2.01E-03
ENSG00000141756	FKBP10	0.110	5.79E-03
ENSG00000113328	CCNG1	0.110	2.17E-02
ENSG00000064726	BTBD1	0.110	3.21E-02
ENSG00000143570	SLC39A1	0.111	3.70E-03
ENSG00000135334	AKIRIN2	0.111	2.50E-02
ENSG00000126432	PRDX5	0.111	6.60E-03
ENSG00000135829	DHX9	0.111	1.48E-03
ENSG00000113552	GNPDA1	0.111	1.93E-02
ENSG00000103187	COTL1	0.111	3.23E-03
ENSG00000078369	GNB1	0.111	5.50E-04
ENSG00000105401	CDC37	0.111	3.64E-03
ENSG00000132294	EFR3A	0.111	4.68E-02
ENSG00000134762	DSC3	0.111	2.43E-03
ENSG00000129351	ILF3	0.111	5.13E-04
ENSG00000013306	SLC25A39	0.111	6.99E-03
ENSG00000105968	H2AFV	0.111	6.28E-03
ENSG00000107815	C10orf2	0.111	3.41E-02
ENSG00000160049	DFFA	0.112	1.01E-02
ENSG00000197965	MPZL1	0.112	3.00E-03
ENSG00000164362	TERT	0.112	9.61E-03
ENSG00000150316	CWC15	0.112	3.81E-02

ENSG00000129562	DAD1	0.112	1.10E-02
ENSG00000118579	MED28	0.112	3.31E-02
ENSG00000173457	PPP1R14B	0.112	1.64E-02
ENSG00000148303	RPL7A	0.112	6.86E-04
ENSG00000174021	GNG5	0.112	1.75E-02
ENSG00000164587	RPS14	0.112	2.63E-03
ENSG00000143797	MBOAT2	0.112	2.13E-02
ENSG00000174748	RPL15	0.112	1.60E-03
ENSG00000180979	LRRC57	0.112	4.67E-02
ENSG00000109133	TMEM33	0.112	3.50E-02
ENSG00000076201	PTPN23	0.113	2.18E-02
ENSG00000116521	SCAMP3	0.113	3.61E-02
ENSG00000108094	CUL2	0.113	3.62E-02
ENSG00000141424	SLC39A6	0.113	1.16E-02
ENSG00000108523	RNF167	0.113	4.41E-03
ENSG00000107175	CREB3	0.113	3.96E-02
ENSG00000184983	NDUFA6	0.113	3.52E-02
ENSG00000131165	CHMP1A	0.113	3.26E-02
ENSG00000118246	FASTKD2	0.113	2.26E-02
ENSG00000090054	SPTLC1	0.113	1.64E-02
ENSG00000022267	FHL1	0.113	1.92E-02
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ENSG00000153310	FAM49B	0.114	1.79E-02
ENSG00000126945	HNRNPH2	0.114	4.45E-02
ENSG00000138182	KIF20B	0.114	8.04E-03
ENSG00000130340	SNX9	0.114	1.88E-02
ENSG00000196642	RABL6	0.114	2.99E-02
ENSG00000130713	EXOSC2	0.114	2.71E-02
ENSG00000125779	PANK2	0.114	1.64E-02
ENSG00000130638	ATXN10	0.114	2.41E-02
ENSG00000172336	POP7	0.114	3.93E-02
ENSG00000173020	ADRBK1	0.114	1.90E-02
ENSG00000096746	HNRNPH3	0.114	2.20E-03
ENSG00000103257	SLC7A5	0.114	2.08E-03
ENSG00000184076	UQCR10	0.114	1.53E-02
ENSG00000180773	SLC36A4	0.114	4.50E-02
ENSG00000112514	CUTA	0.114	4.05E-02
ENSG00000182899	RPL35A	0.115	2.34E-02
ENSG00000029363	BCLAF1	0.115	6.02E-03
ENSG00000134086	VHL	0.115	4.16E-02
ENSG00000179271	GADD45GIP1	0.115	1.46E-02
ENSG00000169299	PGM2	0.115	2.23E-02
ENSG00000124571	XPO5	0.115	3.04E-03

ENSG00000104980	TIMM44	0.115	4.15E-02
ENSG00000136518	ACTL6A	0.115	1.01E-02
ENSG00000274523	WBSCR16	0.115	2.73E-02
ENSG00000150768	DLAT	0.115	1.89E-02
ENSG00000005156	LIG3	0.115	4.14E-02
ENSG00000111707	SUDS3	0.115	2.78E-02
ENSG00000149136	SSRP1	0.115	7.14E-04
ENSG00000084733	RAB10	0.115	1.25E-02
ENSG00000136636	KCTD3	0.115	1.45E-02
ENSG00000128524	ATP6V1F	0.115	2.81E-02
ENSG00000196576	PLXNB2	0.115	6.20E-03
ENSG00000101224	CDC25B	0.116	2.59E-03
ENSG00000138448	ITGAV	0.116	5.51E-03
ENSG00000132313	MRPL35	0.116	4.48E-02
ENSG00000162627	SNX7	0.116	4.95E-02
ENSG00000104522	TSTA3	0.116	1.06E-02
ENSG00000105426	PTPRS	0.116	1.49E-02
ENSG00000124193	SRSF6	0.116	7.78E-04
ENSG00000173207	CKS1B	0.116	1.25E-02
ENSG00000177485	ZBTB33	0.116	2.07E-02
ENSG00000074201	CLNS1A	0.116	8.42E-03
ENSG00000106484	MEST	0.116	9.21E-03
ENSG00000196155	PLEKHG4	0.116	4.03E-02
ENSG00000144713	RPL32	0.116	1.46E-03
ENSG00000124172	ATP5E	0.116	5.94E-03
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ENSG00000212907	MT-ND4L	0.117	3.20E-02
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ENSG00000100504	PYGL	0.117	2.26E-03
ENSG00000124207	CSE1L	0.117	2.08E-03
ENSG00000196262	PPIA	0.117	8.06E-04
ENSG00000197081	IGF2R	0.117	3.78E-03
ENSG00000134247	PTGFRN	0.117	1.63E-03
ENSG00000130402	ACTN4	0.117	2.61E-03
ENSG00000103591	AAGAB	0.117	1.49E-02
ENSG00000141385	AFG3L2	0.117	1.17E-02
ENSG00000064601	CTSA	0.117	3.53E-03
ENSG00000213551	DNAJC9	0.117	5.06E-03
ENSG00000213523	SRA1	0.117	1.60E-02
ENSG00000130508	PXDN	0.117	3.62E-03
ENSG00000186847	KRT14	0.117	1.63E-03
ENSG00000177156	TALDO1	0.117	3.52E-03
ENSG00000182534	MXRA7	0.117	2.09E-03

ENSG00000125249	RAP2A	0.117	3.43E-02
ENSG00000078747	ITCH	0.117	2.07E-03
ENSG00000100764	PSMC1	0.117	7.36E-03
ENSG00000058804	NDC1	0.118	1.25E-02
ENSG00000078124	ACER3	0.118	2.21E-02
ENSG00000173113	TRMT112	0.118	8.90E-03
ENSG00000115365	LANCL1	0.118	2.15E-02
ENSG00000105486	LIG1	0.118	2.52E-02
ENSG00000164308	ERAP2	0.118	1.56E-02
ENSG00000063601	MTMR1	0.118	1.24E-02
ENSG00000131828	PDHA1	0.118	3.65E-03
ENSG00000182718	ANXA2	0.118	5.97E-04
ENSG00000101444	AHCY	0.118	1.06E-03
ENSG00000121766	ZCCHC17	0.118	1.18E-02
ENSG00000112339	HBS1L	0.118	6.79E-03
ENSG00000134955	SLC37A2	0.118	2.98E-02
ENSG00000088766	CRLS1	0.118	1.59E-02
ENSG00000084090	STARD7	0.118	2.65E-03
ENSG00000198242	RPL23A	0.118	4.37E-03
ENSG00000134440	NARS	0.118	1.09E-02
ENSG00000161249	DMKN	0.119	7.61E-03
ENSG00000168268	NT5DC2	0.119	7.35E-03
ENSG00000135940	COX5B	0.119	1.02E-02
ENSG00000185238	PRMT3	0.119	2.39E-02
ENSG00000065183	WDR3	0.119	6.59E-03
ENSG00000141279	NPEPPS	0.119	5.45E-03
ENSG00000132589	FLOT2	0.119	3.27E-03
ENSG00000082641	NFE2L1	0.119	5.19E-04
ENSG00000184575	XPOT	0.119	1.04E-02
ENSG00000215021	PHB2	0.119	1.94E-03
ENSG00000065154	OAT	0.119	1.32E-02
ENSG00000186081	KRT5	0.119	8.42E-05
ENSG00000185787	MORF4L1	0.119	3.51E-03
ENSG00000140575	IQGAP1	0.119	6.17E-04
ENSG00000117676	RPS6KA1	0.119	1.42E-02
ENSG00000109854	HTATIP2	0.119	2.42E-02
ENSG00000168487	BMP1	0.119	2.07E-02
ENSG00000114391	RPL24	0.119	1.53E-03
ENSG00000180530	NRIP1	0.119	1.39E-02
ENSG00000076984	MAP2K7	0.120	1.84E-02
ENSG00000145741	BTF3	0.120	9.48E-04
ENSG00000057252	SOAT1	0.120	4.92E-02
ENSG00000106153	CHCHD2	0.120	6.28E-03

ENSG00000171960	PPIH	0.120	3.03E-02
ENSG00000137074	APTX	0.120	2.41E-02
ENSG00000105726	ATP13A1	0.120	1.56E-02
ENSG00000090863	GLG1	0.120	1.42E-03
ENSG00000135070	ISCA1	0.120	4.92E-02
ENSG00000231500	RPS18	0.120	1.03E-03
ENSG00000169136	ATF5	0.120	3.64E-02
ENSG00000129071	MBD4	0.120	1.75E-02
ENSG00000163636	PSMD6	0.120	6.67E-03
ENSG00000117593	DARS2	0.120	1.50E-02
ENSG00000100348	TXN2	0.120	6.56E-03
ENSG00000135387	CAPRIN1	0.120	6.64E-04
ENSG00000139697	SBNO1	0.120	9.98E-03
ENSG00000106785	TRIM14	0.120	9.14E-03
ENSG00000171467	ZNF318	0.121	2.08E-02
ENSG00000137411	VARS2	0.121	2.55E-02
ENSG00000004897	CDC27	0.121	1.26E-03
ENSG00000110925	CSRNP2	0.121	1.39E-02
ENSG00000130821	SLC6A8	0.121	4.31E-03
ENSG00000118705	RPN2	0.121	8.47E-04
ENSG00000140264	SERF2	0.121	3.84E-03
ENSG00000148484	RSU1	0.121	1.15E-02
ENSG00000117362	APH1A	0.121	6.59E-03
ENSG00000117411	B4GALT2	0.121	1.70E-02
ENSG00000008130	NADK	0.121	1.22E-02
ENSG00000115216	NRBP1	0.121	4.83E-03
ENSG00000171208	NETO2	0.121	6.02E-03
ENSG00000173065	FAM222B	0.121	1.38E-02
ENSG00000130254	SAFB2	0.121	4.72E-03
ENSG00000111142	METAP2	0.121	4.75E-03
ENSG00000141367	CLTC	0.121	8.81E-04
ENSG00000148334	PTGES2	0.122	2.27E-02
ENSG00000197702	PARVA	0.122	2.27E-02
ENSG00000176407	KCMF1	0.122	4.96E-03
ENSG00000125944	HNRNPR	0.122	8.04E-04
ENSG00000111669	TPI1	0.122	6.95E-04
ENSG00000166326	TRIM44	0.122	4.95E-04
ENSG00000108953	YWHAE	0.122	6.70E-04
ENSG00000153113	CAST	0.122	1.53E-03
ENSG00000163293	NIPAL1	0.122	1.49E-02
ENSG00000185479	KRT6B	0.122	4.54E-02
ENSG00000164818	DNAAF5	0.122	1.90E-02
ENSG00000147677	EIF3H	0.122	1.78E-03

ENSG00000119414	PPP6C	0.122	1.19E-02
ENSG00000062485	CS	0.122	1.24E-03
ENSG00000265354	TIMM23	0.122	1.10E-02
ENSG00000135476	ESPL1	0.122	2.31E-02
ENSG00000141480	ARRB2	0.123	4.95E-02
ENSG00000091483	FH	0.123	2.22E-02
ENSG00000160752	FDPS	0.123	5.07E-03
ENSG00000174444	RPL4	0.123	1.23E-04
ENSG00000124098	FAM210B	0.123	4.90E-03
ENSG00000153786	ZDHHC7	0.123	4.69E-03
ENSG00000081154	PCNP	0.123	3.08E-02
ENSG00000102144	PGK1	0.123	4.77E-04
ENSG00000175334	BANF1	0.123	3.93E-03
ENSG00000172354	GNB2	0.123	1.01E-02
ENSG00000271601	LIX1L	0.123	4.27E-02
ENSG00000114491	UMPS	0.123	1.34E-02
ENSG00000130741	EIF2S3	0.123	1.75E-03
ENSG00000142937	RPS8	0.123	6.99E-04
ENSG00000172380	GNG12	0.124	6.38E-03
ENSG00000111684	LPCAT3	0.124	2.19E-02
ENSG00000166681	NGFRAP1	0.124	1.75E-02
ENSG00000137038	TMEM261	0.124	4.04E-02
ENSG00000165389	SPTSSA	0.124	1.93E-02
ENSG00000198918	RPL39	0.124	6.68E-03
ENSG00000166181	API5	0.124	2.76E-03
ENSG00000136819	C9orf78	0.124	4.33E-03
ENSG00000273841	TAF9	0.124	1.24E-02
ENSG00000154370	TRIM11	0.125	1.71E-02
ENSG00000113712	CSNK1A1	0.125	1.31E-03
ENSG00000155229	MMS19	0.125	1.82E-02
ENSG00000168303	MPLKIP	0.125	2.62E-02
ENSG00000158864	NDUFS2	0.125	6.22E-03
ENSG00000108604	SMARCD2	0.125	3.69E-03
ENSG00000172534	HCFC1	0.125	1.53E-02
ENSG00000110321	EIF4G2	0.125	1.61E-04
ENSG00000034510	TMSB10	0.125	3.21E-03
ENSG00000142168	SOD1	0.125	1.41E-03
ENSG00000165678	GHITM	0.125	4.92E-03
ENSG00000130560	UBAC1	0.125	1.16E-02
ENSG00000145833	DDX46	0.125	7.14E-04
ENSG00000108559	NUP88	0.125	1.20E-02
ENSG00000141985	SH3GL1	0.126	9.81E-03
ENSG00000254999	BRK1	0.126	4.92E-03

ENSG00000131069	ACSS2	0.126	6.09E-03
ENSG00000138801	PAPSS1	0.126	1.06E-02
ENSG00000143155	TIPRL	0.126	2.58E-02
ENSG00000160796	NBEAL2	0.126	6.18E-03
ENSG00000113269	RNF130	0.126	9.83E-03
ENSG00000172269	DPAGT1	0.126	1.27E-02
ENSG00000074800	ENO1	0.126	1.95E-04
ENSG00000130177	CDC16	0.126	7.86E-03
ENSG00000159377	PSMB4	0.126	3.31E-03
ENSG00000095261	PSMD5	0.126	8.47E-03
ENSG00000133316	WDR74	0.126	3.63E-02
ENSG00000116906	GNPAT	0.126	3.07E-02
ENSG00000113460	BRIX1	0.126	2.73E-03
ENSG00000164054	SHISA5	0.126	6.38E-03
ENSG00000143164	DCAF6	0.127	7.56E-03
ENSG00000084774	CAD	0.127	2.72E-03
ENSG00000123094	RASSF8	0.127	1.72E-02
ENSG00000166295	ANAPC16	0.127	1.61E-02
ENSG00000122729	ACO1	0.127	1.86E-02
ENSG00000133112	TPT1	0.127	1.63E-04
ENSG00000169813	HNRNPF	0.127	1.75E-04
ENSG00000136731	UGGT1	0.127	4.70E-03
ENSG00000160679	CHTOP	0.127	6.35E-03
ENSG00000133816	MICAL2	0.127	1.26E-03
ENSG00000105576	TNPO2	0.127	1.54E-03
ENSG00000253729	PRKDC	0.127	3.52E-04
ENSG00000182774	RPS17	0.127	3.95E-02
ENSG00000237550	RPL9P9	0.127	3.03E-02
ENSG00000161638	ITGA5	0.127	3.70E-03
ENSG00000244038	DDOST	0.127	9.43E-04
ENSG00000141429	GALNT1	0.127	2.90E-03
ENSG00000068366	ACSL4	0.127	2.46E-03
ENSG00000108298	RPL19	0.127	8.33E-04
ENSG00000137504	CREBZF	0.127	2.46E-02
ENSG00000148798	INA	0.128	3.23E-02
ENSG00000110955	ATP5B	0.128	7.25E-04
ENSG00000172340	SUCLG2	0.128	7.97E-03
ENSG00000011260	UTP18	0.128	4.24E-02
ENSG00000123159	GIPC1	0.128	1.62E-02
ENSG00000048140	TSPAN17	0.128	1.67E-02
ENSG00000134153	EMC7	0.128	6.84E-03
ENSG00000090924	PLEKHG2	0.128	6.05E-03
ENSG00000060749	QSER1	0.128	2.94E-03

ENSG00000092201	SUPT16H	0.128	4.99E-04
ENSG00000060558	GNA15	0.128	8.79E-03
ENSG00000054118	THRAP3	0.128	8.96E-04
ENSG00000168724	DNAJC21	0.128	1.39E-02
ENSG00000029725	RABEP1	0.128	3.27E-03
ENSG00000241685	ARPC1A	0.128	1.07E-03
ENSG00000105193	RPS16	0.128	5.21E-04
ENSG00000161654	LSM12	0.128	4.37E-03
ENSG00000147889	CDKN2A	0.128	2.60E-02
ENSG00000204568	MRPS18B	0.128	3.37E-03
ENSG00000134910	STT3A	0.128	9.18E-04
ENSG00000133935	C14orf1	0.128	7.55E-03
ENSG00000197324	LRP10	0.128	2.28E-03
ENSG00000111237	VPS29	0.128	4.01E-03
ENSG00000113657	DPYSL3	0.129	2.52E-02
ENSG00000178695	KCTD12	0.129	2.76E-03
ENSG00000111642	CHD4	0.129	3.24E-04
ENSG00000156171	DRAM2	0.129	3.08E-02
ENSG00000111371	SLC38A1	0.129	3.73E-04
ENSG00000115685	PPP1R7	0.129	9.91E-03
ENSG00000167468	GPX4	0.129	1.42E-02
ENSG00000115561	CHMP3	0.129	7.75E-03
ENSG00000067182	TNFRSF1A	0.129	7.62E-03
ENSG00000130202	PVRL2	0.129	2.49E-02
ENSG00000105221	AKT2	0.129	2.71E-03
ENSG00000099341	PSMD8	0.129	9.45E-04
ENSG00000087302	C14orf166	0.129	3.25E-03
ENSG00000072609	CHFR	0.129	4.51E-02
ENSG00000108021	FAM208B	0.129	3.38E-03
ENSG00000125166	GOT2	0.129	1.30E-03
ENSG00000136492	BRIP1	0.129	4.83E-03
ENSG00000125841	NRSN2	0.129	9.95E-03
ENSG00000169718	DUS1L	0.130	8.31E-03
ENSG00000138356	AOX1	0.130	2.54E-02
ENSG00000152240	HAUS1	0.130	4.40E-02
ENSG00000149218	ENDOD1	0.130	1.56E-02
ENSG00000107341	UBE2R2	0.130	3.14E-03
ENSG00000147419	CCDC25	0.130	1.10E-02
ENSG00000089050	RBBP9	0.130	1.39E-02
ENSG00000136937	NCBP1	0.130	9.64E-03
ENSG00000178952	TUFM	0.130	5.79E-04
ENSG00000071626	DAZAP1	0.130	7.83E-04
ENSG00000105618	PRPF31	0.130	1.21E-02

ENSG00000117632	STMN1	0.130	1.48E-03
ENSG00000121552	CSTA	0.130	3.37E-02
ENSG00000039123	SKIV2L2	0.130	1.25E-03
ENSG00000169714	CNBP	0.130	5.24E-04
ENSG00000132612	VPS4A	0.130	3.80E-02
ENSG00000090621	PABPC4	0.130	5.55E-04
ENSG00000147274	RBMX	0.130	1.95E-04
ENSG00000126005	MMP24-AS1	0.131	2.03E-02
ENSG00000071054	MAP4K4	0.131	2.02E-04
ENSG00000126107	HECTD3	0.131	1.34E-02
ENSG00000168476	REEP4	0.131	4.37E-02
ENSG00000185122	HSF1	0.131	1.58E-02
ENSG00000067334	DNTTIP2	0.131	4.27E-03
ENSG00000230989	HSBP1	0.131	6.47E-03
ENSG00000100813	ACIN1	0.131	2.96E-04
ENSG00000124783	SSR1	0.131	4.50E-03
ENSG00000124733	MEA1	0.131	3.55E-03
ENSG00000197728	RPS26	0.131	2.80E-03
ENSG00000144048	DUSP11	0.132	8.36E-03
ENSG00000150753	CCT5	0.132	1.50E-04
ENSG00000158716	DUSP23	0.132	2.26E-02
ENSG00000160753	RUSC1	0.132	2.43E-02
ENSG00000134330	IAH1	0.132	4.44E-02
ENSG00000050165	DKK3	0.132	3.51E-03
ENSG00000142669	SH3BGRL3	0.132	5.74E-04
ENSG00000146433	TMEM181	0.132	1.13E-02
ENSG00000204681	GABBR1	0.132	3.06E-02
ENSG00000147649	MTDH	0.133	2.47E-03
ENSG00000183258	DDX41	0.133	2.02E-03
ENSG00000124535	WRNIP1	0.133	2.76E-03
ENSG00000132716	DCAF8	0.133	1.45E-02
ENSG00000160917	CPSF4	0.133	4.09E-02
ENSG00000115107	STEAP3	0.133	3.61E-02
ENSG00000125844	RRBP1	0.133	5.26E-04
ENSG00000134824	FADS2	0.133	2.01E-03
ENSG00000087191	PSMC5	0.133	1.31E-03
ENSG00000167515	TRAPPC2L	0.133	4.49E-02
ENSG00000169217	CD2BP2	0.133	3.45E-03
ENSG00000197756	RPL37A	0.133	3.80E-03
ENSG00000187257	RSBN1L	0.133	4.16E-02
ENSG00000105197	TIMM50	0.133	1.47E-02
ENSG00000164405	UQCRQ	0.133	1.42E-02
ENSG00000182022	CHST15	0.133	7.89E-03

ENSG00000123575	FAM199X	0.133	1.42E-02
ENSG00000183283	DAZAP2	0.134	3.59E-04
ENSG00000140455	USP3	0.134	1.43E-02
ENSG00000100220	RTCB	0.134	4.24E-03
ENSG00000063244	U2AF2	0.134	5.27E-04
ENSG00000126088	UROD	0.134	6.59E-03
ENSG00000092140	G2E3	0.134	4.13E-02
ENSG00000171219	CDC42BPG	0.134	1.24E-02
ENSG00000138092	CENPO	0.134	4.91E-03
ENSG00000183684	ALYREF	0.134	3.61E-03
ENSG00000137814	HAUS2	0.134	5.04E-03
ENSG00000120725	SIL1	0.134	1.18E-02
ENSG00000137812	CASC5	0.134	1.70E-03
ENSG00000008838	MED24	0.134	2.97E-03
ENSG00000180304	OAZ2	0.134	1.07E-02
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ENSG00000166794	PPIB	0.135	6.45E-04
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ENSG00000002834	LASP1	0.135	1.70E-04
ENSG00000119396	RAB14	0.135	2.30E-03
ENSG00000115761	NOL10	0.135	5.29E-03
ENSG00000163785	RYK	0.135	6.09E-03
ENSG00000175324	LSM1	0.135	1.89E-02
ENSG00000055332	EIF2AK2	0.135	4.39E-03
ENSG00000143179	UCK2	0.135	3.60E-03
ENSG00000156599	ZDHHC5	0.135	3.09E-04
ENSG00000059588	TARBP1	0.135	4.63E-02
ENSG00000188846	RPL14	0.135	1.70E-03
ENSG00000131238	PPT1	0.135	2.89E-04
ENSG00000080819	CPOX	0.135	1.27E-02
ENSG00000105325	FZR1	0.135	2.24E-02
ENSG00000185324	CDK10	0.135	3.45E-02
ENSG00000106591	MRPL32	0.135	4.32E-03
ENSG00000112306	RPS12	0.135	3.36E-04
ENSG00000145354	CISD2	0.135	1.12E-02
ENSG00000136156	ITM2B	0.135	1.93E-03
ENSG00000182195	LDOC1	0.135	4.28E-02
ENSG00000099219	ERMP1	0.135	5.87E-03
ENSG00000101346	POFUT1	0.135	1.82E-04
ENSG00000114209	PDCD10	0.135	6.29E-03
ENSG00000142751	GPN2	0.135	1.35E-02
ENSG00000172172	MRPL13	0.135	2.63E-02

ENSG00000120837	NFYB	0.136	4.78E-02
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ENSG00000163428	LRRC58	0.136	7.31E-03
ENSG00000169567	HINT1	0.136	1.33E-02
ENSG00000272391	POM121C	0.136	3.29E-03
ENSG00000211445	GPX3	0.136	3.19E-04
ENSG00000105202	FBL	0.136	1.90E-03
ENSG00000057757	PITHD1	0.136	2.44E-02
ENSG00000178741	COX5A	0.136	5.90E-03
ENSG00000171865	RNASEH1	0.136	2.57E-02
ENSG00000169062	UPF3A	0.136	1.12E-02
ENSG00000089022	MAPKAPK5	0.136	6.52E-03
ENSG00000122299	ZC3H7A	0.136	1.08E-02
ENSG00000008513	ST3GAL1	0.136	2.73E-03
ENSG00000103811	CTSH	0.136	2.06E-02
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ENSG00000105329	TGFB1	0.136	9.10E-03
ENSG00000103510	KAT8	0.136	4.30E-02
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ENSG00000099204	ABLIM1	0.137	1.01E-03
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ENSG00000149925	ALDOA	0.137	5.47E-04
ENSG00000070047	PHRF1	0.137	4.55E-03
ENSG00000196943	NOP9	0.137	1.50E-03
ENSG00000137804	NUSAP1	0.137	2.72E-04
ENSG00000163257	DCAF16	0.137	7.46E-03
ENSG00000130699	TAF4	0.137	5.83E-03
ENSG00000181924	COA4	0.137	1.85E-02
ENSG00000105220	GPI	0.138	3.27E-03
ENSG00000126391	FRMD8	0.138	6.96E-03
ENSG00000138279	ANXA7	0.138	1.81E-03
ENSG00000119318	RAD23B	0.138	4.30E-04
ENSG00000124333	VAMP7	0.138	7.67E-03
ENSG00000169564	PCBP1	0.138	8.47E-04
ENSG00000172785	CBWD1	0.138	7.41E-03
ENSG00000180008	SOCS4	0.138	2.42E-02
ENSG00000185127	C6orf120	0.138	3.11E-02
ENSG00000177697	CD151	0.138	7.09E-03
ENSG00000187555	USP7	0.139	3.92E-04
ENSG00000175066	GK5	0.139	2.77E-02

ENSG00000187498	COL4A1	0.139	1.41E-02
ENSG00000102054	RBBP7	0.139	1.10E-03
ENSG00000101182	PSMA7	0.139	7.14E-04
ENSG00000107164	FUBP3	0.139	4.36E-04
ENSG00000099795	NDUFB7	0.139	1.10E-02
ENSG00000165661	QSOX2	0.139	4.67E-03
ENSG00000104325	DECR1	0.139	2.25E-02
ENSG00000089280	FUS	0.139	7.31E-05
ENSG00000129636	ITFG1	0.139	2.12E-03
ENSG00000214046	SMIM7	0.139	4.92E-02
ENSG00000135720	DYNC1LI2	0.139	4.69E-04
ENSG00000008952	SEC62	0.139	2.90E-03
ENSG00000160972	PPP1R16A	0.139	3.51E-02
ENSG00000133275	CSNK1G2	0.139	5.55E-03
ENSG00000104979	C19orf53	0.139	1.04E-02
ENSG00000122359	ANXA11	0.139	1.04E-03
ENSG00000117280	RAB29	0.139	7.75E-03
ENSG00000100479	POLE2	0.140	2.86E-02
ENSG00000129354	AP1M2	0.140	1.22E-02
ENSG00000165802	NSMF	0.140	8.51E-03
ENSG00000079459	FDFT1	0.140	2.45E-04
ENSG00000143198	MGST3	0.140	7.07E-03
ENSG00000115241	PPM1G	0.140	1.43E-04
ENSG00000204713	TRIM27	0.140	1.41E-03
ENSG00000072110	ACTN1	0.140	4.91E-04
ENSG00000123892	RAB38	0.140	6.80E-03
ENSG00000151413	NUBPL	0.140	3.34E-02
ENSG00000108671	PSMD11	0.140	7.85E-04
ENSG00000163933	RFT1	0.140	1.03E-02
ENSG00000265190	ANXA8	0.141	1.36E-04
ENSG00000060138	YBX3	0.141	5.36E-04
ENSG00000143256	PFDN2	0.141	8.01E-03
ENSG00000118816	CCNI	0.141	1.13E-03
ENSG00000140374	ETFA	0.141	2.99E-03
ENSG00000174791	RIN1	0.141	9.20E-03
ENSG00000234741	GAS5	0.141	3.37E-03
ENSG00000204392	LSM2	0.141	3.68E-02
ENSG00000123933	MXD4	0.141	3.01E-02
ENSG00000152661	GJA1	0.141	2.14E-03
ENSG00000154719	MRPL39	0.141	2.19E-02
ENSG00000014641	MDH1	0.141	7.31E-03
ENSG00000084093	REST	0.141	2.79E-03
ENSG00000134108	ARL8B	0.141	2.10E-03

ENSG00000135049	AGTPBP1	0.141	3.08E-02
ENSG00000147684	NDUFB9	0.141	2.42E-03
ENSG00000198763	MT-ND2	0.141	2.59E-04
ENSG00000174106	LEMD3	0.141	6.42E-03
ENSG00000135318	NT5E	0.141	7.82E-04
ENSG00000096060	FKBP5	0.141	2.25E-04
ENSG00000142733	MAP3K6	0.141	1.55E-02
ENSG00000157500	APPL1	0.142	2.14E-03
ENSG00000178234	GALNT11	0.142	3.15E-02
ENSG00000184900	SUMO3	0.142	4.45E-04
ENSG00000169258	GPRIN1	0.142	3.52E-02
ENSG00000174744	BRMS1	0.142	5.73E-03
ENSG00000105127	AKAP8	0.142	4.33E-03
ENSG00000157778	PSMG3	0.142	2.69E-02
ENSG00000156970	BUB1B	0.142	1.09E-03
ENSG00000051620	HEBP2	0.142	2.02E-03
ENSG00000189046	ALKBH2	0.142	3.92E-02
ENSG00000104408	EIF3E	0.142	1.64E-03
ENSG00000172590	MRPL52	0.142	1.85E-02
ENSG00000168958	MFF	0.142	5.51E-03
ENSG00000103266	STUB1	0.142	2.72E-02
ENSG00000198301	SDAD1	0.142	2.67E-03
ENSG00000173960	UBXN2A	0.142	1.48E-02
ENSG00000168259	DNAJC7	0.142	5.08E-04
ENSG00000167863	ATP5H	0.142	2.99E-03
ENSG00000142156	COL6A1	0.143	1.73E-02
ENSG00000134285	FKBP11	0.143	4.92E-02
ENSG00000130706	ADRM1	0.143	3.95E-03
ENSG00000114030	KPNA1	0.143	4.00E-04
ENSG00000125691	RPL23	0.143	4.98E-05
ENSG00000116750	UCHL5	0.143	2.32E-02
ENSG00000145425	RPS3A	0.143	1.02E-04
ENSG00000129235	TXNDC17	0.143	5.08E-03
ENSG00000006744	ELAC2	0.143	1.25E-03
ENSG00000084754	HADHA	0.144	2.95E-04
ENSG00000168615	ADAM9	0.144	5.58E-04
ENSG00000090520	DNAJB11	0.144	6.96E-04
ENSG00000113732	ATP6V0E1	0.144	1.20E-03
ENSG00000143126	CELSR2	0.144	4.54E-03
ENSG00000154723	ATP5J	0.144	9.09E-04
ENSG00000116251	RPL22	0.144	2.59E-04
ENSG00000115866	DARS	0.144	4.13E-03
ENSG00000149480	MTA2	0.144	2.74E-04

ENSG00000110108	TMEM109	0.144	6.38E-03
ENSG00000071564	TCF3	0.144	1.73E-03
ENSG00000137364	TPMT	0.144	2.46E-02
ENSG00000055044	NOP58	0.144	8.44E-04
ENSG00000147164	SNX12	0.144	5.90E-03
ENSG00000092964	DPYSL2	0.144	2.22E-03
ENSG00000163191	S100A11	0.144	7.65E-05
ENSG00000138160	KIF11	0.144	6.26E-04
ENSG00000100239	PPP6R2	0.144	9.87E-03
ENSG00000100410	PHF5A	0.144	2.70E-02
ENSG00000168234	TTC39C	0.144	4.95E-02
ENSG00000090889	KIF4A	0.144	7.43E-03
ENSG00000141378	PTRH2	0.144	6.15E-03
ENSG00000170421	KRT8	0.144	4.72E-04
ENSG00000138175	ARL3	0.144	2.29E-02
ENSG00000163902	RPN1	0.144	4.52E-05
ENSG00000104915	STX10	0.145	1.30E-02
ENSG00000001036	FUCA2	0.145	1.89E-03
ENSG00000001167	NFYA	0.145	7.82E-03
ENSG00000168394	TAP1	0.145	3.57E-02
ENSG00000266472	MRPS21	0.145	2.87E-03
ENSG00000196700	ZNF512B	0.145	2.54E-03
ENSG00000113068	PFDN1	0.145	1.63E-03
ENSG00000261236	BOP1	0.145	1.38E-02
ENSG00000197930	ERO1A	0.145	7.74E-04
ENSG00000181222	POLR2A	0.145	1.29E-03
ENSG00000101000	PROCR	0.145	5.23E-03
ENSG00000173141	MRPL57	0.145	2.78E-02
ENSG00000128989	ARPP19	0.145	2.06E-03
ENSG00000122140	MRPS2	0.145	6.68E-03
ENSG00000204856	FAM216A	0.145	4.79E-02
ENSG00000110047	EHD1	0.145	2.37E-03
ENSG00000129194	SOX15	0.145	5.38E-03
ENSG00000065518	NDUFB4	0.146	8.08E-03
ENSG00000134884	ARGLU1	0.146	2.44E-03
ENSG00000162512	SDC3	0.146	3.89E-03
ENSG00000214160	ALG3	0.146	3.19E-03
ENSG00000118046	STK11	0.146	7.36E-03
ENSG00000158711	ELK4	0.146	4.14E-03
ENSG00000067533	RRP15	0.146	1.65E-02
ENSG00000085872	CHERP	0.146	4.61E-03
ENSG00000066027	PPP2R5A	0.146	1.14E-02
ENSG00000100138	SNU13	0.146	1.68E-03

ENSG00000008283	CYB561	0.146	1.39E-02
ENSG00000157870	FAM213B	0.146	2.72E-02
ENSG00000163682	RPL9	0.146	6.84E-04
ENSG00000143418	CERS2	0.146	1.96E-04
ENSG00000183741	CBX6	0.146	2.26E-02
ENSG00000198791	CNOT7	0.147	5.67E-04
ENSG00000169446	MMGT1	0.147	3.08E-03
ENSG00000131966	ACTR10	0.147	6.62E-03
ENSG00000123064	DDX54	0.147	1.02E-03
ENSG00000185298	CCDC137	0.147	5.55E-03
ENSG00000105821	DNAJC2	0.147	3.03E-03
ENSG00000100422	CERK	0.147	1.57E-02
ENSG00000089006	SNX5	0.147	1.18E-03
ENSG00000148300	REXO4	0.147	2.16E-02
ENSG00000131779	PEX11B	0.147	4.10E-02
ENSG00000069011	PITX1	0.147	6.59E-03
ENSG00000119707	RBM25	0.147	4.20E-04
ENSG00000177707	PVRL3	0.147	3.66E-02
ENSG00000114270	COL7A1	0.147	1.10E-02
ENSG00000163714	U2SURP	0.148	3.39E-04
ENSG00000127838	PNKD	0.148	2.52E-02
ENSG00000175782	SLC35E3	0.148	3.58E-02
ENSG00000173621	LRFN4	0.148	9.23E-03
ENSG00000185201	IFITM2	0.148	9.52E-04
ENSG00000197894	ADH5	0.148	1.20E-03
ENSG00000132698	RAB25	0.148	4.19E-02
ENSG00000176619	LMNB2	0.148	1.10E-04
ENSG00000144306	SCRN3	0.148	4.59E-02
ENSG00000104823	ECH1	0.148	1.85E-02
ENSG00000112237	CCNC	0.148	1.96E-03
ENSG00000149100	EIF3M	0.148	1.22E-03
ENSG00000128274	A4GALT	0.148	2.33E-02
ENSG00000112695	COX7A2	0.148	2.70E-03
ENSG00000156261	CCT8	0.148	3.04E-04
ENSG00000277791	PSMB3	0.148	7.54E-03
ENSG00000164062	APEH	0.148	1.11E-03
ENSG00000185414	MRPL30	0.148	6.69E-03
ENSG00000151233	GXYLT1	0.148	3.00E-02
ENSG00000161642	ZNF385A	0.149	2.10E-03
ENSG00000115211	EIF2B4	0.149	8.77E-03
ENSG00000025708	TYMP	0.149	6.59E-03
ENSG00000185885	IFITM1	0.149	5.14E-03
ENSG00000125875	TBC1D20	0.149	9.05E-04

ENSG00000171863	RPS7	0.149	2.97E-03
ENSG00000197785	ATAD3A	0.149	4.08E-03
ENSG00000123213	NLN	0.149	1.20E-03
ENSG00000136897	MRPL50	0.149	1.33E-02
ENSG00000167085	PHB	0.149	2.83E-04
ENSG00000171488	LRRC8C	0.149	1.95E-02
ENSG00000213246	SUPT4H1	0.149	6.67E-03
ENSG00000149557	FEZ1	0.149	2.08E-02
ENSG00000140990	NDUFB10	0.149	8.32E-04
ENSG00000109475	RPL34	0.149	5.35E-04
ENSG00000171858	RPS21	0.149	8.36E-03
ENSG00000049656	CLPTM1L	0.149	2.83E-03
ENSG00000004455	AK2	0.150	5.18E-05
ENSG00000152990	ADGRA3	0.150	1.44E-03
ENSG00000099800	TIMM13	0.150	7.42E-03
ENSG00000132507	EIF5A	0.150	2.97E-04
ENSG00000153187	HNRNPU	0.150	1.04E-04
ENSG00000175414	ARL10	0.150	1.16E-02
ENSG00000140307	GTF2A2	0.150	1.04E-02
ENSG00000102900	NUP93	0.150	2.48E-03
ENSG00000160957	RECQL4	0.150	2.97E-02
ENSG00000089154	GCN1	0.150	4.96E-04
ENSG00000164307	ERAP1	0.150	3.63E-03
ENSG00000109790	KLHL5	0.150	1.97E-03
ENSG00000087077	TRIP6	0.150	8.83E-04
ENSG00000165410	CFL2	0.150	2.25E-02
ENSG00000073921	PICALM	0.150	8.56E-04
ENSG00000164611	PTTG1	0.150	2.59E-04
ENSG00000136942	RPL35	0.150	1.64E-04
ENSG00000140691	ARMC5	0.151	3.30E-02
ENSG00000124134	KCNS1	0.151	1.17E-02
ENSG00000186283	TOR3A	0.151	1.49E-02
ENSG00000164109	MAD2L1	0.151	3.23E-03
ENSG00000109189	USP46	0.151	3.38E-02
ENSG00000055211	GINM1	0.151	7.71E-03
ENSG00000100749	VRK1	0.151	6.44E-03
ENSG00000163170	BOLA3	0.151	4.10E-02
ENSG00000089009	RPL6	0.151	2.15E-05
ENSG00000120063	GNA13	0.151	3.01E-03
ENSG00000119328	FAM206A	0.151	1.08E-02
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ENSG00000136238	RAC1	0.151	4.65E-05
ENSG00000196218	RYR1	0.151	3.03E-02

ENSG00000128340	RAC2	0.151	5.82E-04
ENSG00000165629	ATP5C1	0.151	1.84E-03
ENSG00000076043	REXO2	0.151	9.90E-03
ENSG00000197747	S100A10	0.151	3.70E-04
ENSG00000156411	C14orf2	0.152	1.54E-02
ENSG00000198856	OSTC	0.152	1.16E-02
ENSG00000107581	EIF3A	0.152	1.64E-05
ENSG00000142657	PGD	0.152	1.96E-04
ENSG00000196547	MAN2A2	0.152	2.50E-02
ENSG00000221823	PPP3R1	0.152	2.23E-02
ENSG00000172315	TP53RK	0.152	1.05E-02
ENSG00000175354	PTPN2	0.152	4.30E-03
ENSG00000065548	ZC3H15	0.152	9.67E-04
ENSG00000198836	OPA1	0.152	3.26E-03
ENSG00000048544	MRPS10	0.152	5.63E-03
ENSG00000141456	PELP1	0.153	2.45E-03
ENSG00000134375	TIMM17A	0.153	7.74E-03
ENSG00000145912	NHP2	0.153	7.41E-04
ENSG00000140263	SORD	0.153	1.00E-03
ENSG00000140740	UQCRC2	0.153	9.80E-05
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ENSG00000163399	ATP1A1	0.153	5.80E-05
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ENSG00000184220	CMSS1	0.153	7.47E-03
ENSG00000119487	MAPKAP1	0.153	1.88E-04
ENSG00000169976	SF3B5	0.153	5.61E-03
ENSG00000139842	CUL4A	0.153	5.46E-04
ENSG00000144677	CTDSPL	0.153	8.15E-04
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ENSG00000175634	RPS6KB2	0.153	5.82E-03
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ENSG00000185475	TMEM179B	0.153	3.89E-02
ENSG00000106608	URGCP	0.154	2.83E-03
ENSG00000184916	JAG2	0.154	1.50E-02
ENSG00000147100	SLC16A2	0.154	1.54E-02
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ENSG00000156587	UBE2L6	0.154	7.75E-03
ENSG00000133657	ATP13A3	0.154	1.13E-03
ENSG00000120675	DNAJC15	0.154	5.18E-03
ENSG00000039068	CDH1	0.154	4.37E-05
ENSG00000111615	KRR1	0.154	1.44E-03
ENSG00000183576	SETD3	0.154	5.23E-03
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ENSG00000125827	TMX4	0.154	1.20E-03
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ENSG00000185896	LAMP1	0.155	9.42E-05
ENSG00000156535	CD109	0.155	1.69E-04
ENSG00000128609	NDUFA5	0.155	5.82E-03
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ENSG00000170759	KIF5B	0.155	6.72E-05
ENSG00000169727	GPS1	0.155	2.68E-03
ENSG00000132382	MYBBP1A	0.155	7.85E-04
ENSG00000089094	KDM2B	0.155	2.81E-02
ENSG00000143761	ARF1	0.155	3.08E-04
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ENSG00000101443	WFDC2	0.155	4.97E-02
ENSG00000155755	TMEM237	0.155	1.01E-02
ENSG00000171109	MFN1	0.155	9.03E-03
ENSG00000198890	PRMT6	0.155	1.70E-02
ENSG00000089248	ERP29	0.156	1.27E-04
ENSG00000141526	SLC16A3	0.156	3.29E-04
ENSG00000081307	UBA5	0.156	1.21E-02
ENSG00000183955	SETD8	0.156	3.79E-04
ENSG00000159199	ATP5G1	0.156	1.52E-03
ENSG00000090581	GNPTG	0.156	3.22E-02
ENSG00000116212	LRRC42	0.156	7.33E-03
ENSG00000152234	ATP5A1	0.156	5.11E-05
ENSG00000144579	CTDSP1	0.156	4.46E-03
ENSG00000127990	SGCE	0.156	4.03E-02
ENSG00000253304	TMEM200B	0.156	3.96E-02
ENSG00000167283	ATP5L	0.156	2.23E-03
ENSG00000090316	MAEA	0.157	1.17E-03
ENSG00000114446	IFT57	0.157	1.54E-02
ENSG00000198860	TSEN15	0.157	2.01E-02
ENSG00000189067	LITAF	0.157	9.11E-05
ENSG00000148229	POLE3	0.157	7.81E-05
ENSG00000152455	SUV39H2	0.157	2.36E-02
ENSG00000137547	MRPL15	0.157	4.43E-03
ENSG00000069020	MAST4	0.157	1.09E-04
ENSG00000136280	CCM2	0.157	1.23E-02
ENSG00000132434	LANCL2	0.157	3.10E-02
ENSG00000169057	MECP2	0.157	1.05E-03
ENSG00000229117	RPL41	0.157	3.05E-05
ENSG00000136718	IMP4	0.157	1.30E-03
ENSG00000186687	LYRM7	0.157	6.04E-03

ENSG00000136045	PWP1	0.157	2.78E-03
ENSG00000012211	PRICKLE3	0.157	2.44E-02
ENSG00000188157	AGRN	0.158	1.04E-03
ENSG00000117899	MESDC2	0.158	2.11E-03
ENSG00000168291	PDHB	0.158	1.82E-03
ENSG00000110931	CAMKK2	0.158	2.63E-03
ENSG00000130204	TOMM40	0.158	1.11E-03
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ENSG00000183527	PSMG1	0.158	3.63E-03
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ENSG00000165280	VCP	0.158	1.41E-04
ENSG00000125821	DTD1	0.158	3.06E-03
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ENSG00000167642	SPINT2	0.159	1.62E-03
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ENSG00000241468	ATP5J2	0.159	2.26E-02
ENSG00000053371	AKR7A2	0.159	1.00E-02
ENSG00000161267	BDH1	0.159	1.42E-02
ENSG00000057608	GDI2	0.159	2.77E-05
ENSG00000174780	SRP72	0.159	7.99E-05
ENSG00000115339	GALNT3	0.159	3.90E-03
ENSG00000158109	TPRG1L	0.159	1.30E-02
ENSG00000101558	VAPA	0.159	9.05E-04
ENSG00000070081	NUCB2	0.159	5.81E-03
ENSG00000169599	NFU1	0.159	1.46E-02
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ENSG00000115649	CNPPD1	0.159	5.10E-03
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ENSG00000139168	ZCRB1	0.159	1.20E-03
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ENSG00000154277	UCHL1	0.160	1.21E-02
ENSG00000166333	ILK	0.160	3.73E-04
ENSG00000123131	PRDX4	0.160	6.67E-04
ENSG00000159063	ALG8	0.160	1.69E-02

ENSG00000161981	SNRNP25	0.160	4.47E-02
ENSG00000180228	PRKRA	0.160	4.12E-03
ENSG00000138326	RPS24	0.160	4.59E-05
ENSG00000120314	WDR55	0.160	7.87E-04
ENSG00000065427	KARS	0.160	3.21E-05
ENSG00000164050	PLXNB1	0.160	8.46E-04
ENSG00000068001	HYAL2	0.160	1.25E-02
ENSG00000129515	SNX6	0.160	1.22E-03
ENSG00000142798	HSPG2	0.160	8.93E-03
ENSG00000144118	RALB	0.160	2.27E-03
ENSG00000106803	SEC61B	0.160	3.51E-03
ENSG00000089693	MLF2	0.160	9.08E-05
ENSG00000143320	CRABP2	0.160	3.07E-02
ENSG00000178188	SH2B1	0.160	6.49E-03
ENSG00000147224	PRPS1	0.160	1.10E-03
ENSG00000129680	MAP7D3	0.161	2.23E-03
ENSG00000166200	COPS2	0.161	2.43E-03
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ENSG00000105887	MTPN	0.161	4.44E-04
ENSG00000138029	HADHB	0.161	5.37E-04
ENSG00000155034	FBXL18	0.161	1.72E-02
ENSG00000090487	SPG21	0.161	3.59E-03
ENSG00000085491	SLC25A24	0.161	8.96E-04
ENSG00000111786	SRSF9	0.161	2.15E-04
ENSG00000182809	CRIP2	0.161	6.52E-03
ENSG00000172809	RPL38	0.161	6.82E-05
ENSG00000141580	WDR45B	0.161	1.34E-04
ENSG00000106086	PLEKHA8	0.161	1.01E-02
ENSG00000163956	LRPAP1	0.161	6.33E-04
ENSG00000136830	FAM129B	0.161	2.15E-04
ENSG00000147400	CETN2	0.161	3.12E-03
ENSG00000128159	TUBGCP6	0.161	7.55E-03
ENSG00000169230	PRELID1	0.161	7.60E-05
ENSG00000189159	HN1	0.161	6.25E-04
ENSG00000122034	GTF3A	0.161	9.96E-04
ENSG00000214706	IFRD2	0.161	3.58E-03
ENSG00000010244	ZNF207	0.162	2.47E-04
ENSG00000117395	EBNA1BP2	0.162	5.21E-04
ENSG00000088247	KHSRP	0.162	1.03E-04
ENSG00000134152	KATNBL1	0.162	3.47E-02
ENSG00000122958	VPS26A	0.162	4.67E-03
ENSG00000227057	WDR46	0.162	3.17E-03
ENSG00000009307	CSDE1	0.162	6.55E-05

ENSG00000175470	PPP2R2D	0.162	5.23E-03
ENSG00000242498	ARPIN	0.162	4.91E-03
ENSG00000102898	NUTF2	0.162	2.45E-04
ENSG00000114554	PLXNA1	0.162	8.06E-04
ENSG00000079785	DDX1	0.162	5.77E-04
ENSG00000176890	TYMS	0.162	7.55E-04
ENSG00000072864	NDE1	0.162	4.90E-04
ENSG00000143549	TPM3	0.162	1.07E-04
ENSG00000070814	TCOF1	0.162	8.98E-05
ENSG00000149930	TAOK2	0.162	4.63E-03
ENSG00000175216	CKAP5	0.162	3.10E-05
ENSG00000253276	CCDC71L	0.162	5.85E-03
ENSG00000263465	SRSF8	0.162	2.75E-03
ENSG00000065613	SLK	0.162	9.94E-05
ENSG00000146007	ZMAT2	0.162	1.41E-04
ENSG00000119013	NDUFB3	0.162	4.14E-03
ENSG00000180011	ZADH2	0.162	2.25E-03
ENSG00000006715	VPS41	0.162	7.69E-03
ENSG00000151287	TEX30	0.162	3.34E-02
ENSG00000151726	ACSL1	0.162	3.03E-03
ENSG00000145592	RPL37	0.162	1.01E-05
ENSG00000172732	MUS81	0.163	4.54E-03
ENSG00000166562	SEC11C	0.163	1.34E-02
ENSG00000154174	TOMM70A	0.163	3.23E-04
ENSG00000166598	HSP90B1	0.163	4.56E-05
ENSG00000164919	COX6C	0.163	5.20E-03
ENSG00000101213	PTK6	0.163	4.95E-03
ENSG00000177030	DEAF1	0.163	1.33E-02
ENSG00000143183	TMCO1	0.163	7.79E-04
ENSG00000125817	CENPB	0.163	2.37E-03
ENSG00000131236	CAP1	0.163	1.01E-05
ENSG00000115825	PRKD3	0.163	2.76E-03
ENSG00000186298	PPP1CC	0.163	1.03E-03
ENSG00000163001	CFAP36	0.163	1.36E-02
ENSG00000172890	NADSYN1	0.163	7.01E-03
ENSG00000145907	G3BP1	0.163	4.60E-05
ENSG00000213585	VDAC1	0.164	3.41E-05
ENSG00000111331	OAS3	0.164	2.66E-03
ENSG00000122406	RPL5	0.164	1.06E-05
ENSG00000099624	ATP5D	0.164	1.30E-02
ENSG00000049449	RCN1	0.164	6.32E-04
ENSG00000067560	RHOA	0.164	1.56E-05
ENSG00000186832	KRT16	0.164	2.38E-02

ENSG00000100335	MIEF1	0.164	3.53E-04
ENSG00000180185	FAHD1	0.164	1.44E-02
ENSG00000154813	DPH3	0.164	6.80E-03
ENSG00000061938	TNK2	0.164	5.94E-03
ENSG00000136522	MRPL47	0.164	4.25E-03
ENSG00000119285	HEATR1	0.165	2.25E-04
ENSG00000134243	SORT1	0.165	1.62E-03
ENSG00000087266	SH3BP2	0.165	8.04E-04
ENSG00000127184	COX7C	0.165	1.24E-03
ENSG00000101843	PSMD10	0.165	1.14E-02
ENSG00000188643	S100A16	0.165	5.78E-05
ENSG00000135404	CD63	0.165	3.61E-05
ENSG00000148384	INPP5E	0.165	1.24E-02
ENSG00000131981	LGALS3	0.165	9.54E-05
ENSG00000184887	BTBD6	0.165	1.72E-02
ENSG00000165119	HNRNPK	0.165	2.15E-05
ENSG00000185829	ARL17A	0.165	8.87E-03
ENSG00000112739	PRPF4B	0.166	2.54E-04
ENSG00000206075	SERPINB5	0.166	1.34E-04
ENSG00000144848	ATG3	0.166	2.18E-03
ENSG00000139131	YARS2	0.166	1.71E-02
ENSG00000182544	MFSD5	0.166	2.23E-02
ENSG00000182670	TTC3	0.166	1.18E-04
ENSG00000116871	MAP7D1	0.166	3.88E-04
ENSG00000114450	GNB4	0.166	9.40E-04
ENSG00000141956	PRDM15	0.166	4.37E-02
ENSG00000139684	ESD	0.166	5.26E-04
ENSG00000100596	SPTLC2	0.166	2.11E-03
ENSG00000181396	OGFOD3	0.166	1.68E-02
ENSG00000166710	B2M	0.166	9.91E-05
ENSG00000061794	MRPS35	0.166	1.64E-03
ENSG00000070770	CSNK2A2	0.166	1.15E-04
ENSG00000137720	C11orf1	0.166	2.93E-02
ENSG00000109472	CPE	0.166	6.50E-04
ENSG00000145901	TNIP1	0.167	9.29E-06
ENSG00000164172	MOCS2	0.167	1.30E-03
ENSG00000105254	TBCB	0.167	5.47E-03
ENSG00000101189	MRGBP	0.167	3.74E-03
ENSG00000091317	CMTM6	0.167	2.58E-03
ENSG00000136159	NUDT15	0.167	4.78E-03
ENSG00000165704	HPRT1	0.167	1.64E-03
ENSG00000118418	HMGN3	0.167	2.99E-03
ENSG00000104472	CHRAC1	0.167	1.08E-03

ENSG00000041982	TNC	0.167	2.34E-03
ENSG00000156642	NPTN	0.167	3.95E-04
ENSG00000069329	VPS35	0.167	4.39E-05
ENSG00000165804	ZNF219	0.167	1.46E-02
ENSG00000105676	ARMC6	0.167	1.04E-02
ENSG00000131143	COX4I1	0.167	1.76E-04
ENSG00000051128	HOMER3	0.168	9.80E-03
ENSG00000160818	GPATCH4	0.168	2.53E-04
ENSG00000211460	TSN	0.168	1.22E-03
ENSG00000164167	LSM6	0.168	3.99E-02
ENSG00000185189	NRBP2	0.168	8.36E-03
ENSG00000136305	CIDEB	0.168	1.31E-02
ENSG00000122026	RPL21	0.168	1.33E-05
ENSG00000101152	DNAJC5	0.168	1.35E-04
ENSG00000123353	ORMDL2	0.168	7.44E-03
ENSG00000130935	NOL11	0.168	4.62E-04
ENSG00000153214	TMEM87B	0.168	2.14E-03
ENSG00000166197	NOLC1	0.168	1.12E-05
ENSG00000161791	FMNL3	0.168	7.67E-03
ENSG00000157193	LRP8	0.169	9.05E-04
ENSG00000175793	SFN	0.169	3.83E-05
ENSG00000073578	SDHA	0.169	3.16E-05
ENSG00000197694	SPTAN1	0.169	3.02E-05
ENSG00000163900	TMEM41A	0.169	4.90E-03
ENSG00000137040	RANBP6	0.169	1.30E-02
ENSG00000143314	MRPL24	0.169	1.04E-03
ENSG00000172586	CHCHD1	0.169	4.25E-02
ENSG00000144354	CDCA7	0.169	5.18E-03
ENSG00000110921	MVK	0.169	4.03E-03
ENSG00000137713	PPP2R1B	0.169	9.15E-03
ENSG00000137876	RSL24D1	0.169	3.50E-03
ENSG00000143252	SDHC	0.169	8.33E-04
ENSG00000109606	DHX15	0.169	1.09E-04
ENSG00000196923	PDLIM7	0.170	7.96E-04
ENSG00000226887	ERVMER34-1	0.170	5.04E-04
ENSG00000164466	SFXN1	0.170	1.38E-04
ENSG00000134905	CARS2	0.170	1.30E-03
ENSG00000027697	IFNGR1	0.170	1.70E-03
ENSG00000185009	AP3M1	0.170	2.94E-04
ENSG00000143862	ARL8A	0.170	6.27E-03
ENSG00000167770	OTUB1	0.170	2.11E-03
ENSG00000166913	YWHAB	0.170	6.88E-06
ENSG00000170571	EMB	0.170	4.44E-04

ENSG00000164346	NSA2	0.170	1.59E-04
ENSG00000188211	NCR3LG1	0.170	1.93E-03
ENSG00000188343	FAM92A1	0.170	4.30E-02
ENSG00000166479	TMX3	0.170	4.94E-03
ENSG00000108883	EFTUD2	0.171	3.11E-05
ENSG00000115350	POLE4	0.171	2.54E-02
ENSG00000055070	SZRD1	0.171	1.90E-04
ENSG00000135926	TMBIM1	0.171	7.55E-06
ENSG00000088986	DYNLL1	0.171	8.27E-05
ENSG00000164182	NDUFAF2	0.171	2.18E-03
ENSG00000112655	PTK7	0.171	6.96E-04
ENSG00000141076	CIRH1A	0.171	1.57E-04
ENSG00000170340	B3GNT2	0.171	7.85E-03
ENSG00000183978	COA3	0.171	6.98E-03
ENSG00000069275	NUCKS1	0.171	4.28E-05
ENSG00000118363	SPCS2	0.171	1.51E-03
ENSG00000198363	ASPH	0.171	4.27E-05
ENSG00000160446	ZDHHC12	0.171	8.83E-03
ENSG00000214753	HNRNPUL2	0.171	4.96E-04
ENSG00000153006	SREK1IP1	0.171	3.63E-03
ENSG00000137767	SQRDL	0.171	3.37E-03
ENSG00000143321	HDGF	0.171	1.70E-06
ENSG00000185340	GAS2L1	0.171	1.00E-02
ENSG00000198231	DDX42	0.171	6.25E-05
ENSG00000131446	MGAT1	0.171	2.42E-04
ENSG00000184216	IRAK1	0.171	1.82E-04
ENSG00000111845	PAK1IP1	0.171	5.80E-03
ENSG00000084652	TXLNA	0.172	9.39E-05
ENSG00000088205	DDX18	0.172	3.71E-04
ENSG00000184840	TMED9	0.172	5.46E-04
ENSG00000177106	EPS8L2	0.172	1.03E-03
ENSG00000108256	NUFIP2	0.172	5.83E-05
ENSG00000103642	LACTB	0.172	2.98E-02
ENSG00000101856	PGRMC1	0.172	8.33E-04
ENSG00000137822	TUBGCP4	0.172	2.43E-04
ENSG00000101290	CDS2	0.172	3.57E-04
ENSG00000072210	ALDH3A2	0.172	8.25E-04
ENSG00000067167	TRAM1	0.172	2.91E-04
ENSG00000087087	SRRT	0.172	1.64E-05
ENSG00000203950	FAM127B	0.172	1.79E-03
ENSG00000168827	GFM1	0.172	5.24E-04
ENSG00000150459	SAP18	0.172	6.31E-04
ENSG00000136146	MED4	0.172	4.06E-03

ENSG00000095002	MSH2	0.172	1.74E-03
ENSG00000185101	ANO9	0.172	3.92E-02
ENSG00000273604	C17orf96	0.173	2.71E-02
ENSG00000138413	IDH1	0.173	1.31E-04
ENSG00000130787	HIP1R	0.173	1.30E-03
ENSG00000204160	ZDHHC18	0.173	8.28E-03
ENSG00000149485	FADS1	0.173	2.10E-05
ENSG00000100811	YY1	0.173	6.02E-05
ENSG00000112146	FBXO9	0.173	3.82E-03
ENSG00000118898	PPL	0.173	1.33E-04
ENSG00000006451	RALA	0.173	5.09E-04
ENSG00000109929	SC5D	0.173	9.56E-04
ENSG00000182240	BACE2	0.173	3.87E-04
ENSG00000116649	SRM	0.174	5.67E-04
ENSG00000164520	RAET1E	0.174	2.57E-02
ENSG00000065978	YBX1	0.174	1.16E-06
ENSG00000119705	SLIRP	0.174	1.70E-03
ENSG00000146223	RPL7L1	0.174	1.79E-05
ENSG00000138821	SLC39A8	0.174	8.71E-04
ENSG00000146416	AIG1	0.174	1.49E-02
ENSG00000122786	CALD1	0.174	2.62E-05
ENSG00000071462	WBSCR22	0.174	2.09E-04
ENSG00000183578	TNFAIP8L3	0.174	4.45E-02
ENSG00000277972	CISD3	0.174	2.74E-02
ENSG00000122705	CLTA	0.174	9.04E-05
ENSG00000198720	ANKRD13B	0.174	1.93E-02
ENSG00000113810	SMC4	0.175	1.33E-04
ENSG00000171848	RRM2	0.175	6.61E-06
ENSG00000005022	SLC25A5	0.175	8.33E-06
ENSG00000175110	MRPS22	0.175	1.60E-03
ENSG00000104763	ASAH1	0.175	6.32E-04
ENSG00000004399	PLXND1	0.175	2.17E-02
ENSG00000009830	POMT2	0.175	1.41E-02
ENSG00000130429	ARPC1B	0.175	1.18E-03
ENSG00000126067	PSMB2	0.175	1.20E-05
ENSG00000147955	SIGMAR1	0.175	2.83E-05
ENSG00000108588	CCDC47	0.175	1.46E-04
ENSG00000136261	BZW2	0.175	8.21E-04
ENSG00000005884	ITGA3	0.175	1.57E-05
ENSG00000108010	GLRX3	0.175	7.93E-04
ENSG00000126709	IFI6	0.175	4.92E-03
ENSG00000183648	NDUFB1	0.175	2.69E-02
ENSG00000164258	NDUFS4	0.175	2.29E-03

ENSG00000169710	FASN	0.175	3.39E-04
ENSG00000110422	HIPK3	0.175	5.96E-05
ENSG00000161921	CXCL16	0.176	1.66E-02
ENSG00000150779	TIMM8B	0.176	1.40E-02
ENSG00000228594	C1orf233	0.176	1.43E-02
ENSG00000196591	HDAC2	0.176	1.58E-05
ENSG00000136783	NIPSNAP3A	0.176	1.84E-02
ENSG00000119314	PTBP3	0.176	2.95E-05
ENSG00000116120	FARSB	0.176	5.42E-04
ENSG00000149357	LAMTOR1	0.176	3.50E-03
ENSG00000197006	METTL9	0.176	2.19E-04
ENSG00000141098	GFOD2	0.176	1.21E-02
ENSG00000187605	TET3	0.176	1.47E-04
ENSG00000033050	ABCF2	0.176	6.63E-05
ENSG00000183605	SFXN4	0.176	2.47E-02
ENSG00000120265	PCMT1	0.176	1.34E-04
ENSG00000136379	ABHD17C	0.176	1.63E-02
ENSG00000147065	MSN	0.177	1.02E-05
ENSG00000142227	EMP3	0.177	1.67E-03
ENSG00000157227	MMP14	0.177	5.96E-05
ENSG00000143947	RPS27A	0.177	4.25E-05
ENSG00000087269	NOP14	0.177	1.12E-04
ENSG00000153936	HS2ST1	0.177	2.70E-02
ENSG00000082515	MRPL22	0.177	5.10E-04
ENSG00000197586	ENTPD6	0.177	4.72E-04
ENSG00000066117	SMARCD1	0.177	1.17E-04
ENSG00000184428	TOP1MT	0.178	1.23E-02
ENSG00000006625	GGCT	0.178	1.48E-02
ENSG00000147669	POLR2K	0.178	2.62E-03
ENSG00000182552	RWDD4	0.178	3.24E-03
ENSG00000013297	CLDN11	0.178	4.29E-02
ENSG00000135316	SYNCRIP	0.178	2.49E-05
ENSG00000114867	EIF4G1	0.178	2.17E-06
ENSG00000101246	ARFRP1	0.178	7.34E-04
ENSG00000185651	UBE2L3	0.178	1.26E-05
ENSG00000124787	RPP40	0.178	2.92E-02
ENSG00000198015	MRPL42	0.178	2.53E-03
ENSG00000164924	YWHAZ	0.178	1.27E-05
ENSG00000111605	CPSF6	0.178	2.92E-05
ENSG00000148843	PDCD11	0.178	1.46E-04
ENSG00000143793	C1orf35	0.178	2.67E-02
ENSG00000228716	DHFR	0.178	2.48E-05
ENSG00000161544	CYGB	0.178	9.46E-03

ENSG00000134809	TIMM10	0.178	1.91E-02
ENSG00000171530	TBCA	0.179	2.56E-04
ENSG00000125356	NDUFA1	0.179	4.29E-03
ENSG00000197045	GMFB	0.179	3.52E-03
ENSG00000164211	STARD4	0.179	3.39E-03
ENSG00000100216	TOMM22	0.179	8.66E-05
ENSG00000123144	C19orf43	0.179	2.43E-03
ENSG00000185088	RPS27L	0.179	1.75E-02
ENSG00000213412	HNRNPA1P33	0.179	6.04E-03
ENSG00000171574	ZNF584	0.179	4.97E-02
ENSG00000179195	ZNF664	0.179	4.59E-04
ENSG00000198783	ZNF830	0.179	8.57E-03
ENSG00000102241	HTATSF1	0.179	3.90E-04
ENSG00000213390	ARHGAP19	0.179	1.67E-02
ENSG00000174574	AKIRIN1	0.179	2.13E-04
ENSG00000119787	ATL2	0.179	1.27E-03
ENSG00000159399	HK2	0.179	4.50E-05
ENSG00000077097	TOP2B	0.180	1.87E-05
ENSG00000130958	SLC35D2	0.180	2.69E-02
ENSG00000110651	CD81	0.180	2.03E-04
ENSG00000177192	PUS1	0.180	4.40E-03
ENSG00000163527	STT3B	0.180	1.77E-04
ENSG00000117519	CNN3	0.180	1.39E-04
ENSG00000196975	ANXA4	0.180	1.73E-03
ENSG00000139921	TMX1	0.180	1.41E-03
ENSG00000172830	SSH3	0.180	5.91E-04
ENSG00000149418	ST14	0.180	2.68E-04
ENSG00000144635	DYNC1LI1	0.180	1.45E-03
ENSG00000162909	CAPN2	0.180	7.20E-06
ENSG00000185515	BRCC3	0.181	2.51E-03
ENSG00000105447	GRWD1	0.181	1.54E-03
ENSG00000104886	PLEKHJ1	0.181	1.36E-02
ENSG00000188243	COMMD6	0.181	2.86E-02
ENSG00000165915	SLC39A13	0.181	9.57E-04
ENSG00000166902	MRPL16	0.181	1.19E-03
ENSG00000160211	G6PD	0.181	4.91E-04
ENSG00000168653	NDUFS5	0.181	1.46E-04
ENSG00000111726	CMAS	0.181	2.37E-03
ENSG00000024526	DEPDC1	0.181	7.37E-04
ENSG00000178718	RPP25	0.182	2.41E-03
ENSG00000106609	TMEM248	0.182	3.58E-05
ENSG00000096092	TMEM14A	0.182	2.88E-02
ENSG00000167625	ZNF526	0.182	2.23E-02

ENSG00000064703	DDX20	0.182	2.36E-04
ENSG00000109534	GAR1	0.182	1.17E-02
ENSG00000130702	LAMA5	0.182	5.36E-04
ENSG00000198729	PPP1R14C	0.182	3.51E-04
ENSG00000181061	HIGD1A	0.182	3.92E-02
ENSG00000167004	PDIA3	0.182	3.72E-06
ENSG00000167461	RAB8A	0.182	1.79E-05
ENSG00000165264	NDUFB6	0.182	2.00E-02
ENSG00000135451	TROAP	0.182	1.03E-03
ENSG00000121957	GPSM2	0.182	8.26E-05
ENSG00000180667	YOD1	0.182	5.84E-04
ENSG00000104413	ESRP1	0.183	4.37E-05
ENSG00000103415	HMOX2	0.183	4.96E-04
ENSG00000173905	GOLIM4	0.183	1.19E-04
ENSG00000154582	TCEB1	0.183	3.36E-04
ENSG00000106617	PRKAG2	0.183	1.79E-03
ENSG00000167615	LENG8	0.183	4.20E-04
ENSG00000115275	MOGS	0.183	7.10E-04
ENSG00000136710	CCDC115	0.183	3.00E-02
ENSG00000092010	PSME1	0.183	3.69E-04
ENSG00000242485	MRPL20	0.183	7.86E-04
ENSG00000025796	SEC63	0.183	9.27E-05
ENSG00000136490	LIMD2	0.183	1.34E-02
ENSG00000160789	LMNA	0.183	3.18E-05
ENSG00000148672	GLUD1	0.183	1.26E-05
ENSG00000101193	GID8	0.183	5.21E-05
ENSG00000138363	ATIC	0.184	6.23E-05
ENSG00000129824	RPS4Y1	0.184	1.56E-03
ENSG00000117724	CENPF	0.184	5.02E-06
ENSG00000213619	NDUFS3	0.184	4.14E-03
ENSG00000116459	ATP5F1	0.184	1.76E-05
ENSG00000011009	LYPLA2	0.184	1.07E-03
ENSG00000101474	APMAP	0.184	2.52E-05
ENSG00000104147	OIP5	0.184	4.61E-02
ENSG00000105974	CAV1	0.185	8.69E-06
ENSG00000135698	MPHOSPH6	0.185	6.44E-03
ENSG00000106244	PDAP1	0.185	2.39E-05
ENSG00000129911	KLF16	0.185	3.70E-03
ENSG00000092820	EZR	0.185	1.95E-06
ENSG00000071539	TRIP13	0.185	2.70E-04
ENSG00000035499	DEPDC1B	0.185	1.50E-03
ENSG00000184787	UBE2G2	0.185	1.36E-05
ENSG00000183624	HMCES	0.185	3.65E-04

ENSG00000124767	GLO1	0.185	2.67E-05
ENSG00000165819	METTL3	0.186	3.00E-03
ENSG00000132432	SEC61G	0.186	2.47E-03
ENSG00000155368	DBI	0.186	1.35E-05
ENSG00000131171	SH3BGRL	0.186	7.25E-03
ENSG00000178896	EXOSC4	0.186	1.44E-02
ENSG00000165609	NUDT5	0.186	5.06E-05
ENSG00000134709	HOOK1	0.186	7.45E-03
ENSG00000013563	DNASE1L1	0.186	2.14E-02
ENSG00000237190	CDKN2AIPNL	0.186	1.46E-03
ENSG00000182093	WRB	0.186	1.68E-02
ENSG00000184363	PKP3	0.186	5.93E-04
ENSG00000156928	MALSU1	0.186	1.48E-02
ENSG00000171204	TMEM126B	0.186	1.01E-02
ENSG00000126698	DNAJC8	0.186	6.50E-06
ENSG00000174013	FBXO45	0.186	2.74E-04
ENSG00000128951	DUT	0.186	1.06E-03
ENSG00000006432	MAP3K9	0.186	1.11E-04
ENSG00000119820	YIPF4	0.187	7.62E-03
ENSG00000245910	SNHG6	0.187	3.71E-03
ENSG00000143771	CNIH4	0.187	8.64E-04
ENSG00000196396	PTPN1	0.187	2.23E-06
ENSG00000147604	RPL7	0.187	5.46E-06
ENSG00000134248	LAMTOR5	0.187	1.93E-03
ENSG00000159335	PTMS	0.187	1.59E-04
ENSG00000198689	SLC9A6	0.187	1.02E-02
ENSG00000138035	PNPT1	0.187	7.74E-05
ENSG00000176022	B3GALT6	0.187	2.31E-03
ENSG00000152256	PDK1	0.187	4.08E-03
ENSG00000143061	IGSF3	0.187	2.19E-05
ENSG00000143653	SCCPDH	0.188	1.39E-02
ENSG00000099810	MTAP	0.188	1.56E-04
ENSG00000135862	LAMC1	0.188	1.18E-06
ENSG00000168282	MGAT2	0.188	3.29E-04
ENSG00000162368	CMPK1	0.188	4.20E-04
ENSG00000050130	JKAMP	0.188	2.99E-03
ENSG00000131724	IL13RA1	0.188	1.36E-04
ENSG00000204267	TAP2	0.188	1.32E-04
ENSG00000101335	MYL9	0.188	4.90E-03
ENSG00000175591	P2RY2	0.188	8.20E-03
ENSG00000148344	PTGES	0.188	3.86E-03
ENSG00000135486	HNRNPA1	0.188	1.72E-06
ENSG00000077232	DNAJC10	0.189	9.13E-05

ENSG00000113391	FAM172A	0.189	2.04E-02
ENSG00000131899	LLGL1	0.189	4.95E-04
ENSG00000134802	SLC43A3	0.189	1.14E-03
ENSG00000110218	PANX1	0.189	8.90E-04
ENSG00000132485	ZRANB2	0.189	8.27E-04
ENSG00000099783	HNRNPM	0.189	2.78E-05
ENSG00000232677	LINC00665	0.189	3.06E-03
ENSG00000175826	CTDNEP1	0.189	1.52E-03
ENSG00000116199	FAM20B	0.189	5.86E-05
ENSG00000108424	KPNB1	0.189	3.72E-07
ENSG00000067704	IARS2	0.189	5.93E-05
ENSG00000136100	VPS36	0.189	3.03E-03
ENSG00000106633	GCK	0.189	2.26E-02
ENSG00000140682	TGFB1I1	0.190	7.19E-03
ENSG00000136938	ANP32B	0.190	1.48E-05
ENSG00000105339	DENND3	0.190	7.80E-03
ENSG00000077147	TM9SF3	0.190	7.60E-05
ENSG00000173660	UQCRH	0.190	3.25E-05
ENSG00000140983	RHOT2	0.190	2.12E-03
ENSG00000023734	STRAP	0.190	5.57E-06
ENSG00000213903	LTB4R	0.190	7.93E-04
ENSG00000123146	ADGRE5	0.190	1.37E-03
ENSG00000188997	KCTD21	0.190	4.75E-02
ENSG00000183864	TOB2	0.190	3.14E-04
ENSG00000159140	SON	0.190	6.44E-07
ENSG00000176444	CLK2	0.190	8.79E-04
ENSG00000100242	SUN2	0.190	2.20E-04
ENSG00000113575	PPP2CA	0.190	3.36E-05
ENSG00000196510	ANAPC7	0.190	6.44E-04
ENSG00000106367	AP1S1	0.191	1.34E-04
ENSG00000121774	KHDRBS1	0.191	7.26E-06
ENSG00000170854	MINA	0.191	1.63E-03
ENSG00000257267	ZNF271P	0.191	4.56E-03
ENSG00000172757	CFL1	0.191	2.53E-06
ENSG00000054116	TRAPPC3	0.191	1.23E-04
ENSG00000106636	YKT6	0.191	1.57E-05
ENSG00000143537	ADAM15	0.191	4.36E-04
ENSG00000000419	DPM1	0.191	6.32E-04
ENSG00000084073	ZMPSTE24	0.191	6.06E-04
ENSG00000110917	MLEC	0.191	1.37E-05
ENSG00000164105	SAP30	0.191	9.32E-03
ENSG00000108654	DDX5	0.191	6.50E-07
ENSG00000118564	FBXL5	0.191	2.06E-03

ENSG00000116584	ARHGEF2	0.191	9.57E-06
ENSG00000125843	AP5S1	0.191	3.84E-02
ENSG00000131871	VIMP	0.191	2.83E-03
ENSG00000160877	NACC1	0.191	1.19E-03
ENSG00000169715	MT1E	0.191	1.63E-04
ENSG00000198276	UCKL1	0.192	5.68E-03
ENSG00000150093	ITGB1	0.192	1.41E-06
ENSG00000214113	LYRM4	0.192	4.83E-03
ENSG00000198492	YTHDF2	0.192	2.39E-05
ENSG00000058668	ATP2B4	0.192	9.84E-06
ENSG00000107140	TESK1	0.192	7.16E-04
ENSG00000091140	DLD	0.192	8.05E-04
ENSG00000122378	FAM213A	0.192	8.33E-04
ENSG00000130021	PUDP	0.192	1.27E-02
ENSG00000131016	AKAP12	0.192	8.19E-04
ENSG00000099385	BCL7C	0.192	7.86E-03
ENSG00000198612	COPS8	0.192	4.16E-04
ENSG00000074582	BCS1L	0.192	1.03E-03
ENSG00000171055	FEZ2	0.192	2.01E-03
ENSG00000127526	SLC35E1	0.192	1.76E-04
ENSG00000253368	TRNP1	0.192	5.28E-03
ENSG00000103037	SETD6	0.192	2.49E-02
ENSG00000135372	NAT10	0.193	4.63E-05
ENSG00000140350	ANP32A	0.193	1.40E-05
ENSG00000144063	MALL	0.193	1.42E-02
ENSG00000100196	KDELR3	0.193	2.08E-02
ENSG00000105677	TMEM147	0.193	1.76E-03
ENSG00000121057	AKAP1	0.193	1.45E-04
ENSG00000099901	RANBP1	0.193	7.19E-06
ENSG00000166347	CYB5A	0.193	1.73E-02
ENSG00000170142	UBE2E1	0.193	1.06E-04
ENSG00000156471	PTDSS1	0.193	1.68E-05
ENSG00000103495	MAZ	0.193	3.47E-05
ENSG00000000003	TSPAN6	0.193	4.23E-02
ENSG00000166260	COX11	0.193	4.09E-03
ENSG00000123600	METTL8	0.193	7.44E-04
ENSG00000140395	WDR61	0.193	3.03E-03
ENSG00000100028	SNRPD3	0.193	2.92E-05
ENSG00000182287	AP1S2	0.194	4.10E-02
ENSG00000272398	CD24	0.194	2.03E-05
ENSG00000170043	TRAPPC1	0.194	1.56E-03
ENSG00000150787	PTS	0.194	2.96E-02
ENSG00000155366	RHOC	0.194	2.12E-04

ENSG00000006047	YBX2	0.194	2.06E-03
ENSG00000104723	TUSC3	0.194	4.71E-04
ENSG00000110092	CCND1	0.194	1.83E-06
ENSG00000177889	UBE2N	0.194	6.70E-05
ENSG00000122970	IFT81	0.194	5.49E-03
ENSG00000120705	ETF1	0.194	1.09E-06
ENSG00000196924	FLNA	0.194	3.69E-05
ENSG00000137168	PPIL1	0.194	4.54E-04
ENSG00000270647	TAF15	0.194	3.61E-05
ENSG00000175283	DOLK	0.194	5.25E-03
ENSG00000103018	CYB5B	0.194	4.63E-05
ENSG00000071082	RPL31	0.194	2.57E-05
ENSG00000151914	DST	0.194	7.48E-07
ENSG00000179604	CDC42EP4	0.194	2.19E-04
ENSG00000179387	ELMOD2	0.195	6.63E-03
ENSG00000163466	ARPC2	0.195	6.41E-07
ENSG00000171345	KRT19	0.195	1.50E-04
ENSG00000102172	SMS	0.195	5.66E-06
ENSG00000157916	RER1	0.195	4.58E-05
ENSG00000171421	MRPL36	0.195	2.20E-03
ENSG00000102554	KLF5	0.195	6.64E-06
ENSG00000156256	USP16	0.195	2.15E-03
ENSG00000108826	MRPL27	0.195	1.93E-02
ENSG00000183520	UTP11L	0.195	9.93E-05
ENSG00000197183	NOL4L	0.195	1.31E-04
ENSG00000243317	C7orf73	0.195	6.36E-04
ENSG00000173442	EHBP1L1	0.195	2.49E-05
ENSG00000264364	DYNLL2	0.195	3.30E-05
ENSG00000121579	NAA50	0.195	3.78E-05
ENSG00000186854	TRABD2A	0.195	4.45E-03
ENSG00000103769	RAB11A	0.195	1.09E-04
ENSG00000244509	APOBEC3C	0.195	1.05E-03
ENSG00000167173	C15orf39	0.195	4.43E-04
ENSG00000144029	MRPS5	0.196	6.21E-05
ENSG00000159069	FBXW5	0.196	1.44E-03
ENSG00000130309	COLGALT1	0.196	3.32E-06
ENSG00000109586	GALNT7	0.196	2.96E-03
ENSG00000120805	ARL1	0.196	3.96E-04
ENSG00000075142	SRI	0.196	1.27E-04
ENSG00000140391	TSPAN3	0.196	5.98E-05
ENSG00000081277	PKP1	0.196	5.96E-06
ENSG00000172057	ORMDL3	0.196	1.34E-03
ENSG00000100726	TELO2	0.196	1.28E-02

ENSG00000104964	AES	0.196	4.42E-05
ENSG00000131435	PDLIM4	0.196	2.70E-03
ENSG00000169908	TM4SF1	0.197	1.09E-03
ENSG00000134602	STK26	0.197	1.56E-03
ENSG00000124209	RAB22A	0.197	1.38E-04
ENSG00000111328	CDK2AP1	0.197	2.04E-03
ENSG00000163634	THOC7	0.197	1.50E-04
ENSG00000106605	BLVRA	0.197	7.23E-03
ENSG00000204977	TRIM13	0.197	2.26E-02
ENSG00000018510	AGPS	0.197	2.38E-04
ENSG00000187147	RNF220	0.197	6.65E-05
ENSG00000170348	TMED10	0.197	2.83E-06
ENSG00000114850	SSR3	0.197	2.31E-05
ENSG00000181704	YIPF6	0.197	2.27E-03
ENSG00000178988	MRFAP1L1	0.197	1.75E-04
ENSG00000213719	CLIC1	0.197	3.98E-06
ENSG00000120992	LYPLA1	0.197	3.82E-03
ENSG00000198899	MT-ATP6	0.197	8.00E-05
ENSG00000232112	TMA7	0.197	1.40E-04
ENSG00000140400	MAN2C1	0.198	4.70E-03
ENSG00000196636	SDHAF3	0.198	2.35E-02
ENSG00000171262	FAM98B	0.198	5.54E-04
ENSG00000142910	TINAGL1	0.198	2.00E-04
ENSG00000140832	MARVELD3	0.198	9.80E-03
ENSG00000184307	ZDHHC23	0.198	3.65E-02
ENSG00000120802	TMPO	0.198	3.05E-05
ENSG00000097033	SH3GLB1	0.198	9.91E-05
ENSG00000151465	CDC123	0.198	1.42E-05
ENSG00000198887	SMC5	0.198	4.71E-05
ENSG00000138760	SCARB2	0.198	1.59E-05
ENSG00000107758	PPP3CB	0.198	1.48E-03
ENSG00000134001	EIF2S1	0.199	1.14E-05
ENSG00000180817	PPA1	0.199	2.52E-05
ENSG00000142945	KIF2C	0.199	1.31E-05
ENSG00000183386	FHL3	0.199	6.34E-03
ENSG00000165672	PRDX3	0.199	6.67E-04
ENSG00000125459	MSTO1	0.199	2.41E-02
ENSG00000116898	MRPS15	0.199	6.10E-05
ENSG00000196363	WDR5	0.199	1.44E-05
ENSG00000132323	ILKAP	0.199	2.45E-03
ENSG00000070423	RNF126	0.199	7.88E-04
ENSG00000173674	EIF1AX	0.199	3.36E-05
ENSG00000100345	MYH9	0.199	1.57E-06

ENSG00000137210	TMEM14B	0.200	7.40E-03
ENSG00000013583	HEBP1	0.200	5.02E-03
ENSG00000093000	NUP50	0.200	9.12E-06
ENSG00000068697	LAPTM4A	0.200	7.45E-05
ENSG00000112667	DNPH1	0.200	5.61E-03
ENSG00000160124	CCDC58	0.200	7.37E-04
ENSG00000146731	CCT6A	0.200	3.99E-06
ENSG00000184992	BRI3BP	0.200	7.99E-05
ENSG00000126003	PLAGL2	0.200	1.27E-05
ENSG00000007520	TSR3	0.200	9.00E-04
ENSG00000164951	PDP1	0.200	1.04E-03
ENSG00000066422	ZBTB11	0.200	1.11E-03
ENSG00000156467	UQCRB	0.200	2.71E-05
ENSG00000160213	CSTB	0.200	1.09E-04
ENSG00000168924	LETM1	0.201	3.17E-05
ENSG00000170515	PA2G4	0.201	7.36E-07
ENSG00000119979	FAM45A	0.201	1.82E-03
ENSG00000129250	KIF1C	0.201	7.18E-06
ENSG00000178252	WDR6	0.201	1.11E-05
ENSG00000198176	TFDP1	0.201	2.03E-06
ENSG00000132361	CLUH	0.201	2.65E-05
ENSG00000085871	MGST2	0.201	2.34E-03
ENSG00000099330	OCEL1	0.201	3.62E-02
ENSG00000135052	GOLM1	0.201	1.97E-05
ENSG00000140545	MFGE8	0.201	3.22E-04
ENSG00000155380	SLC16A1	0.201	6.85E-06
ENSG00000120963	ZNF706	0.201	3.03E-03
ENSG00000198804	MT-CO1	0.202	9.80E-05
ENSG00000100554	ATP6V1D	0.202	2.16E-04
ENSG00000145781	COMMD10	0.202	2.59E-02
ENSG00000068489	PRR11	0.202	5.66E-05
ENSG00000155868	MED7	0.202	3.15E-02
ENSG00000138777	PPA2	0.202	2.15E-03
ENSG00000075239	ACAT1	0.202	7.54E-05
ENSG00000162302	RPS6KA4	0.202	1.47E-04
ENSG00000105376	ICAM5	0.202	2.05E-02
ENSG00000169857	AVEN	0.202	2.92E-02
ENSG00000138069	RAB1A	0.203	8.78E-06
ENSG00000212747	FAM127C	0.203	2.72E-03
ENSG00000164088	PPM1M	0.203	4.59E-02
ENSG00000198901	PRC1	0.203	4.86E-06
ENSG00000110888	CAPRIN2	0.203	4.48E-04
ENSG00000197345	MRPL21	0.203	9.00E-04

ENSG00000139722	VPS37B	0.203	4.42E-04
ENSG00000183856	IQGAP3	0.204	7.87E-05
ENSG00000108561	C1QBP	0.204	2.70E-06
ENSG00000170871	KIAA0232	0.204	5.35E-04
ENSG00000138796	HADH	0.204	4.83E-03
ENSG00000205339	IPO7	0.204	9.67E-06
ENSG00000104419	NDRG1	0.204	2.47E-06
ENSG00000170876	TMEM43	0.204	4.11E-05
ENSG00000134901	KDELC1	0.204	9.66E-03
ENSG00000164332	UBLCP1	0.204	1.64E-03
ENSG00000005893	LAMP2	0.204	1.03E-04
ENSG00000015532	XYLT2	0.204	6.29E-04
ENSG00000198721	ECI2	0.204	2.91E-03
ENSG00000004660	CAMKK1	0.205	1.65E-02
ENSG00000110200	ANAPC15	0.205	1.56E-03
ENSG00000120948	TARDBP	0.205	2.11E-05
ENSG00000142864	SERBP1	0.205	4.24E-07
ENSG00000185803	SLC52A2	0.205	2.49E-03
ENSG00000165169	DYNLT3	0.205	6.00E-03
ENSG00000182518	FAM104B	0.205	3.67E-02
ENSG00000158805	ZNF276	0.205	1.92E-03
ENSG00000168938	PPIC	0.205	1.10E-03
ENSG00000177733	HNRNPA0	0.205	4.85E-06
ENSG00000134333	LDHA	0.205	9.88E-08
ENSG00000110880	CORO1C	0.205	1.20E-06
ENSG00000176595	KBTBD11	0.205	4.25E-02
ENSG00000147676	MAL2	0.205	1.34E-03
ENSG00000129187	DCTD	0.206	4.31E-05
ENSG00000165501	LRR1	0.206	4.84E-03
ENSG00000169288	MRPL1	0.206	7.02E-03
ENSG00000198168	SVIP	0.206	2.07E-02
ENSG00000164713	BRI3	0.206	3.44E-03
ENSG00000187244	BCAM	0.206	3.69E-03
ENSG00000236552	RPL13AP5	0.206	1.45E-02
ENSG00000148840	PPRC1	0.206	3.82E-05
ENSG00000111229	ARPC3	0.206	4.69E-05
ENSG00000069482	GAL	0.206	2.13E-02
ENSG00000047315	POLR2B	0.206	1.27E-05
ENSG00000078668	VDAC3	0.206	3.87E-05
ENSG00000158669	GPAT4	0.206	1.94E-05
ENSG00000103275	UBE2I	0.207	1.13E-06
ENSG00000113119	TMCO6	0.207	6.98E-03
ENSG00000142892	PIGK	0.207	2.78E-03

ENSG00000033011	ALG1	0.207	4.66E-03
ENSG00000146425	DYNLT1	0.207	4.15E-04
ENSG00000168159	RNF187	0.207	1.17E-05
ENSG00000074696	HACD3	0.207	1.32E-05
ENSG00000136450	SRSF1	0.207	7.37E-06
ENSG00000198131	ZNF544	0.207	3.20E-03
ENSG00000134049	IER3IP1	0.208	1.45E-02
ENSG00000162980	ARL5A	0.208	7.83E-04
ENSG00000213281	NRAS	0.208	1.48E-04
ENSG00000272333	KMT2B	0.208	2.32E-04
ENSG00000117450	PRDX1	0.208	4.08E-06
ENSG00000138744	NAAA	0.208	2.37E-02
ENSG00000175130	MARCKSL1	0.208	1.12E-04
ENSG00000177189	RPS6KA3	0.208	6.09E-05
ENSG00000006459	KDM7A	0.208	1.10E-03
ENSG00000063978	RNF4	0.208	7.78E-06
ENSG00000181610	MRPS23	0.208	3.79E-04
ENSG00000127922	SHFM1	0.208	7.33E-05
ENSG00000115364	MRPL19	0.209	2.17E-03
ENSG00000265241	RBM8A	0.209	3.82E-06
ENSG00000178163	ZNF518B	0.209	4.29E-04
ENSG00000112297	AIM1	0.209	8.10E-06
ENSG00000140474	ULK3	0.209	3.46E-03
ENSG00000157992	KRTCAP3	0.209	1.24E-02
ENSG00000166068	SPRED1	0.209	3.50E-04
ENSG00000134308	YWHAQ	0.209	1.55E-06
ENSG00000100567	PSMA3	0.209	2.35E-04
ENSG00000184708	EIF4ENIF1	0.209	1.19E-03
ENSG00000114023	FAM162A	0.210	1.43E-03
ENSG00000116489	CAPZA1	0.210	1.86E-05
ENSG00000102096	PIM2	0.210	4.17E-03
ENSG00000131323	TRAF3	0.210	7.31E-05
ENSG00000205581	HMGN1	0.210	5.29E-06
ENSG00000272888	LINC01578	0.210	4.78E-02
ENSG00000158417	EIF5B	0.211	4.92E-06
ENSG00000145014	TMEM44	0.211	3.54E-02
ENSG00000108582	CPD	0.211	6.61E-06
ENSG00000174238	PITPNA	0.211	1.92E-05
ENSG00000143870	PDIA6	0.211	5.28E-07
ENSG00000168078	PBK	0.211	1.63E-03
ENSG00000197601	FAR1	0.211	5.17E-04
ENSG00000164171	ITGA2	0.211	2.06E-05
ENSG00000108829	LRRC59	0.211	6.80E-07

ENSG00000033100	CHPF2	0.211	8.52E-04
ENSG00000125304	TM9SF2	0.212	3.99E-05
ENSG00000119929	CUTC	0.212	2.47E-03
ENSG00000168389	MFSD2A	0.212	2.85E-05
ENSG00000101911	PRPS2	0.212	1.36E-04
ENSG00000053372	MRTO4	0.212	1.11E-04
ENSG00000129116	PALLD	0.212	6.78E-06
ENSG00000111716	LDHB	0.212	2.39E-06
ENSG00000128641	MYO1B	0.212	3.49E-07
ENSG00000114686	MRPL3	0.212	1.81E-05
ENSG00000184319	RPL23AP82	0.212	1.20E-02
ENSG00000182220	ATP6AP2	0.212	4.71E-05
ENSG00000132963	POMP	0.213	9.37E-05
ENSG00000198055	GRK6	0.213	5.57E-05
ENSG00000148362	C9orf142	0.213	2.94E-02
ENSG00000167005	NUDT21	0.213	1.20E-06
ENSG00000124201	ZNFX1	0.213	1.55E-06
ENSG00000128591	FLNC	0.213	2.58E-03
ENSG00000029153	ARNTL2	0.213	2.95E-05
ENSG00000035687	ADSS	0.213	1.23E-04
ENSG00000109390	NDUFC1	0.213	1.49E-03
ENSG00000085733	CTTN	0.213	5.72E-06
ENSG00000136521	NDUFB5	0.214	7.99E-04
ENSG00000162702	ZNF281	0.214	4.92E-05
ENSG00000153395	LPCAT1	0.214	2.17E-05
ENSG00000106263	EIF3B	0.214	3.71E-06
ENSG00000182963	GJC1	0.214	3.66E-04
ENSG00000113621	TXNDC15	0.214	5.28E-04
ENSG00000111321	LTBR	0.214	1.30E-06
ENSG00000196715	VKORC1L1	0.214	8.50E-05
ENSG00000153179	RASSF3	0.214	5.08E-04
ENSG00000143643	TTC13	0.214	5.27E-03
ENSG00000129084	PSMA1	0.214	3.07E-02
ENSG00000114744	COMMD2	0.214	2.46E-04
ENSG00000162385	MAGOH	0.215	1.75E-04
ENSG00000126953	TIMM8A	0.215	4.03E-02
ENSG00000176386	CDC26	0.215	1.02E-03
ENSG00000167699	GLOD4	0.215	1.68E-04
ENSG00000151694	ADAM17	0.215	9.13E-05
ENSG00000143799	PARP1	0.215	8.96E-07
ENSG00000111906	HDDC2	0.215	4.92E-04
ENSG00000131148	EMC8	0.215	1.64E-03
ENSG00000239900	ADSL	0.216	7.57E-04

ENSG00000100003	SEC14L2	0.216	1.41E-05
ENSG00000165502	RPL36AL	0.216	3.20E-06
ENSG00000076554	TPD52	0.216	3.31E-04
ENSG00000176105	YES1	0.216	3.39E-04
ENSG00000111639	MRPL51	0.216	7.19E-06
ENSG00000162458	FBLIM1	0.216	1.69E-05
ENSG00000104228	TRIM35	0.216	3.24E-04
ENSG00000160014	CALM3	0.217	2.87E-06
ENSG00000153989	NUS1	0.217	1.02E-05
ENSG00000204839	MROH6	0.217	3.34E-03
ENSG00000120437	ACAT2	0.217	7.17E-06
ENSG00000203760	CENPW	0.217	1.25E-02
ENSG00000148459	PDSS1	0.217	5.18E-03
ENSG00000183963	SMTN	0.217	1.12E-04
ENSG00000096063	SRPK1	0.217	2.58E-06
ENSG00000132640	BTBD3	0.218	1.47E-03
ENSG00000166189	HPS6	0.218	2.44E-03
ENSG00000206418	RAB12	0.218	9.90E-05
ENSG00000135723	FHOD1	0.218	6.43E-05
ENSG00000136240	KDELR2	0.219	9.06E-07
ENSG00000176597	B3GNT5	0.219	4.14E-05
ENSG00000078902	TOLLIP	0.219	1.19E-03
ENSG00000135930	EIF4E2	0.219	3.02E-06
ENSG00000169594	BNC1	0.219	1.79E-06
ENSG00000109805	NCAPG	0.219	1.99E-05
ENSG00000152642	GPD1L	0.219	3.84E-02
ENSG00000112576	CCND3	0.220	6.85E-05
ENSG00000160932	LY6E	0.220	2.98E-04
ENSG00000116863	ADPRHL2	0.220	9.61E-04
ENSG00000029993	HMGB3	0.220	2.37E-06
ENSG00000136810	TXN	0.220	3.02E-06
ENSG00000041357	PSMA4	0.220	7.19E-06
ENSG00000023909	GCLM	0.220	1.19E-03
ENSG00000131943	C19orf12	0.220	3.28E-02
ENSG00000204954	C12orf73	0.220	4.15E-02
ENSG00000028310	BRD9	0.220	6.18E-05
ENSG00000140406	MESDC1	0.221	3.47E-04
ENSG00000100568	VTI1B	0.221	4.38E-05
ENSG00000118680	MYL12B	0.221	2.76E-06
ENSG00000178209	PLEC	0.221	2.29E-05
ENSG00000166484	MAPK7	0.221	1.23E-03
ENSG00000146729	GBAS	0.221	3.62E-06
ENSG00000187109	NAP1L1	0.221	8.25E-06

ENSG00000198081	ZBTB14	0.222	2.13E-02
ENSG00000116171	SCP2	0.222	1.67E-03
ENSG00000106976	DNM1	0.222	4.47E-03
ENSG00000168884	TNIP2	0.222	2.75E-03
ENSG00000173726	TOMM20	0.222	8.40E-06
ENSG00000155858	LSM11	0.223	3.53E-03
ENSG00000102178	UBL4A	0.223	2.71E-04
ENSG00000117461	PIK3R3	0.223	1.11E-03
ENSG00000109084	TMEM97	0.223	1.41E-05
ENSG00000149547	EI24	0.223	7.13E-06
ENSG00000102024	PLS3	0.223	2.06E-03
ENSG00000138071	ACTR2	0.223	3.17E-05
ENSG00000116560	SFPQ	0.223	8.22E-08
ENSG00000113387	SUB1	0.223	2.59E-05
ENSG00000112378	PERP	0.223	1.58E-05
ENSG00000154059	IMPACT	0.223	1.99E-03
ENSG00000177370	TIMM22	0.223	1.21E-04
ENSG00000132341	RAN	0.223	3.81E-07
ENSG00000139343	SNRPF	0.224	5.09E-05
ENSG00000277161	PIGW	0.224	9.42E-04
ENSG00000180921	FAM83H	0.224	2.70E-05
ENSG00000198912	C1orf174	0.224	6.08E-04
ENSG00000092295	TGM1	0.224	3.90E-03
ENSG00000105185	PDCD5	0.224	4.48E-06
ENSG00000074071	MRPS34	0.224	2.45E-04
ENSG00000134202	GSTM3	0.224	1.70E-02
ENSG00000241553	ARPC4	0.224	4.08E-04
ENSG00000185825	BCAP31	0.225	3.24E-06
ENSG00000116288	PARK7	0.225	7.45E-06
ENSG00000173418	NAA20	0.225	1.42E-05
ENSG00000189221	MAOA	0.225	5.66E-05
ENSG00000115514	TXNDC9	0.226	1.33E-03
ENSG00000012061	ERCC1	0.226	7.60E-05
ENSG00000107798	LIPA	0.226	5.77E-05
ENSG00000163728	TTC14	0.226	1.77E-03
ENSG00000155506	LARP1	0.226	1.14E-07
ENSG00000130332	LSM7	0.226	1.80E-02
ENSG00000117906	RCN2	0.226	1.66E-03
ENSG00000198130	HIBCH	0.226	3.18E-03
ENSG00000131876	SNRPA1	0.226	3.76E-05
ENSG00000213694	S1PR3	0.226	1.04E-02
ENSG00000171763	SPATA5L1	0.226	6.02E-03
ENSG00000161013	MGAT4B	0.227	3.98E-06

ENSG00000255302	EID1	0.227	7.26E-06
ENSG00000071127	WDR1	0.227	3.41E-07
ENSG00000198952	SMG5	0.227	2.33E-06
ENSG00000203668	CHML	0.227	5.67E-05
ENSG00000102753	KPNA3	0.227	1.65E-05
ENSG00000196531	NACA	0.227	1.52E-06
ENSG00000143977	SNRPG	0.227	1.82E-05
ENSG00000146067	FAM193B	0.227	7.79E-05
ENSG00000109919	MTCH2	0.228	5.50E-06
ENSG00000134287	ARF3	0.228	3.70E-06
ENSG00000112941	PAPD7	0.228	5.78E-06
ENSG00000103496	STX4	0.228	5.95E-04
ENSG00000134970	TMED7	0.228	7.57E-04
ENSG00000026508	CD44	0.228	4.38E-08
ENSG00000072274	TFRC	0.228	1.95E-06
ENSG00000221978	CCNL2	0.228	3.41E-06
ENSG00000085117	CD82	0.228	6.43E-05
ENSG00000137692	DCUN1D5	0.228	3.15E-05
ENSG00000147804	SLC39A4	0.228	1.99E-02
ENSG00000105722	ERF	0.228	1.19E-05
ENSG00000269343	ZNF587B	0.228	3.13E-02
ENSG00000103121	CMC2	0.228	1.62E-03
ENSG00000164040	PGRMC2	0.229	1.14E-04
ENSG00000102390	PBDC1	0.229	2.59E-03
ENSG00000159128	IFNGR2	0.229	5.52E-06
ENSG00000136122	BORA	0.229	8.38E-04
ENSG00000196937	FAM3C	0.229	4.13E-04
ENSG00000140612	SEC11A	0.229	2.64E-05
ENSG00000168273	SMIM4	0.229	4.34E-02
ENSG00000181163	NPM1	0.229	1.03E-07
ENSG00000125753	VASP	0.229	2.44E-05
ENSG00000146409	SLC18B1	0.230	3.20E-03
ENSG00000114978	MOB1A	0.230	1.71E-05
ENSG00000132661	NXT1	0.230	5.37E-04
ENSG00000126749	EMG1	0.230	2.47E-03
ENSG00000184500	PROS1	0.230	2.60E-02
ENSG00000189280	GJB5	0.230	1.59E-04
ENSG00000102309	PIN4	0.231	7.28E-04
ENSG00000163964	PIGX	0.231	7.27E-03
ENSG00000131002	TXLNGY	0.231	1.98E-03
ENSG00000131508	UBE2D2	0.231	5.87E-06
ENSG00000004779	NDUFAB1	0.231	1.66E-03
ENSG00000262919	FAM58A	0.231	9.39E-03

ENSG00000165487	MICU2	0.231	1.38E-04
ENSG00000117335	CD46	0.231	3.32E-06
ENSG00000155959	VBP1	0.231	2.68E-03
ENSG00000089220	PEBP1	0.231	1.24E-06
ENSG00000104341	LAPTM4B	0.231	1.87E-05
ENSG00000069849	ATP1B3	0.231	1.63E-06
ENSG00000100632	ERH	0.231	1.02E-05
ENSG00000100413	POLR3H	0.231	3.39E-04
ENSG00000141696	P3H4	0.231	4.73E-04
ENSG00000131778	CHD1L	0.232	4.64E-04
ENSG00000018408	WWTR1	0.232	3.48E-06
ENSG00000060762	MPC1	0.232	1.95E-03
ENSG00000145220	LYAR	0.232	1.77E-05
ENSG00000169139	UBE2V2	0.232	1.47E-04
ENSG00000171793	CTPS1	0.232	1.36E-06
ENSG00000110700	RPS13	0.232	7.41E-07
ENSG00000099194	SCD	0.232	1.64E-08
ENSG00000115053	NCL	0.232	2.14E-08
ENSG00000105877	DNAH11	0.232	2.62E-02
ENSG00000134419	RPS15A	0.232	4.98E-05
ENSG00000151239	TWF1	0.232	3.68E-05
ENSG00000141101	NOB1	0.232	1.15E-05
ENSG00000135521	LTV1	0.232	4.04E-03
ENSG00000126903	SLC10A3	0.232	1.08E-04
ENSG00000164134	NAA15	0.233	2.46E-05
ENSG00000115946	PNO1	0.233	3.23E-04
ENSG00000160072	ATAD3B	0.233	6.04E-04
ENSG00000156374	PCGF6	0.233	4.64E-03
ENSG00000172171	TEFM	0.233	3.14E-02
ENSG00000010438	PRSS3	0.233	4.42E-02
ENSG00000123179	EBPL	0.233	5.63E-04
ENSG00000090905	TNRC6A	0.233	2.55E-06
ENSG00000166797	FAM96A	0.233	2.13E-04
ENSG00000165644	COMTD1	0.233	2.47E-02
ENSG00000140743	CDR2	0.233	1.73E-04
ENSG00000127585	FBXL16	0.234	2.41E-02
ENSG00000151835	SACS	0.234	7.55E-06
ENSG00000228300	C19orf24	0.234	1.90E-02
ENSG00000223482	NUTM2A-AS1	0.234	4.55E-03
ENSG00000087502	ERGIC2	0.234	2.00E-05
ENSG00000111737	RAB35	0.234	1.36E-05
ENSG00000085788	DDHD2	0.235	2.48E-05
ENSG00000196230	TUBB	0.235	4.25E-09

ENSG00000117500	TMED5	0.235	4.37E-05
ENSG00000143727	ACP1	0.235	4.79E-05
ENSG00000130312	MRPL34	0.235	6.44E-04
ENSG00000134046	MBD2	0.235	1.53E-06
ENSG00000117399	CDC20	0.235	1.36E-06
ENSG00000159217	IGF2BP1	0.235	1.77E-02
ENSG00000178338	ZNF354B	0.235	5.01E-03
ENSG00000186834	HEXIM1	0.235	3.40E-06
ENSG00000122566	HNRNPA2B1	0.236	1.73E-08
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ENSG00000170312	CDK1	0.236	3.04E-06
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ENSG00000163938	GNL3	0.237	2.48E-06
ENSG00000174775	HRAS	0.237	9.27E-05
ENSG00000049245	VAMP3	0.237	2.32E-06
ENSG00000089195	TRMT6	0.237	9.12E-06
ENSG00000250565	ATP6V1E2	0.237	2.10E-02
ENSG00000158792	SPATA2L	0.237	3.43E-02
ENSG00000101608	MYL12A	0.237	2.39E-06
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ENSG00000100387	RBX1	0.238	2.33E-03
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ENSG00000165476	REEP3	0.238	6.28E-05
ENSG00000060491	OGFR	0.238	7.36E-05
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ENSG00000131467	PSME3	0.238	5.21E-08
ENSG00000109736	MFSD10	0.239	7.71E-04
ENSG00000105939	ZC3HAV1	0.239	2.26E-07
ENSG00000189403	HMGB1	0.239	6.22E-08
ENSG00000080986	NDC80	0.239	4.63E-05
ENSG00000116396	KCNC4	0.239	4.05E-02
ENSG00000128944	KNSTRN	0.239	1.82E-05
ENSG00000116473	RAP1A	0.240	1.19E-03
ENSG00000128050	PAICS	0.240	7.31E-07
ENSG00000031081	ARHGAP31	0.240	3.22E-02
ENSG00000111832	RWDD1	0.240	3.88E-05
ENSG00000231925	TAPBP	0.240	7.61E-07
ENSG00000149115	TNKS1BP1	0.240	2.81E-07
ENSG00000116704	SLC35D1	0.241	1.24E-03
ENSG00000161980	POLR3K	0.241	9.88E-03
ENSG00000106852	LHX6	0.241	1.79E-03
ENSG00000197170	PSMD12	0.241	5.76E-06
ENSG00000099814	CEP170B	0.241	2.72E-06

ENSG00000101084	C20orf24	0.241	4.08E-02
ENSG00000151131	C12orf45	0.241	2.39E-02
ENSG00000204220	PFDN6	0.241	1.21E-04
ENSG00000163947	ARHGEF3	0.242	2.97E-05
ENSG00000139641	ESYT1	0.242	1.90E-07
ENSG00000168917	SLC35G2	0.242	1.11E-02
ENSG00000101557	USP14	0.242	8.65E-06
ENSG00000204580	DDR1	0.242	1.17E-07
ENSG00000107130	NCS1	0.242	2.15E-05
ENSG00000119599	DCAF4	0.242	1.21E-02
ENSG00000067064	IDI1	0.242	1.91E-05
ENSG00000146676	PURB	0.242	1.02E-06
ENSG00000139645	ANKRD52	0.242	3.18E-06
ENSG00000106278	PTPRZ1	0.242	8.47E-03
ENSG00000221923	ZNF880	0.242	2.59E-02
ENSG00000133641	C12orf29	0.243	1.96E-03
ENSG00000136108	CKAP2	0.243	1.59E-06
ENSG00000148297	MED22	0.243	1.17E-04
ENSG00000157379	DHRS1	0.243	6.12E-04
ENSG00000168066	SF1	0.243	9.20E-07
ENSG00000175348	TMEM9B	0.243	3.95E-04
ENSG00000095015	MAP3K1	0.243	1.21E-04
ENSG00000160404	TOR2A	0.244	1.14E-02
ENSG00000171314	PGAM1	0.244	8.49E-07
ENSG00000005059	CCDC109B	0.244	8.00E-03
ENSG00000172932	ANKRD13D	0.244	2.16E-04
ENSG00000145040	UCN2	0.244	7.53E-03
ENSG00000064961	HMG20B	0.244	1.48E-05
ENSG00000241399	CD302	0.244	1.80E-02
ENSG00000023697	DERA	0.244	7.31E-05
ENSG00000254087	LYN	0.244	5.69E-05
ENSG00000107833	NPM3	0.244	5.67E-04
ENSG00000104368	PLAT	0.244	6.02E-03
ENSG00000239306	RBM14	0.244	5.46E-05
ENSG00000258289	CHURC1	0.245	7.73E-04
ENSG00000128595	CALU	0.245	1.29E-07
ENSG00000086598	TMED2	0.245	1.77E-05
ENSG00000197498	RPF2	0.246	2.17E-06
ENSG00000147383	NSDHL	0.246	5.73E-05
ENSG00000165688	PMPCA	0.246	1.06E-06
ENSG00000154845	PPP4R1	0.246	1.12E-07
ENSG00000067113	PLPP1	0.247	8.11E-03
ENSG00000170632	ARMC10	0.247	8.08E-05

ENSG00000197951	ZNF71	0.247	7.81E-03
ENSG00000135535	CD164	0.247	7.01E-06
ENSG00000145545	SRD5A1	0.247	1.28E-03
ENSG00000101132	PFDN4	0.247	3.36E-04
ENSG00000226950	DANCR	0.247	1.54E-03
ENSG00000182372	CLN8	0.248	1.62E-03
ENSG00000126804	ZBTB1	0.248	3.12E-05
ENSG00000147687	TATDN1	0.248	5.66E-04
ENSG00000075790	BCAP29	0.248	7.69E-06
ENSG00000071994	PDCD2	0.248	1.52E-05
ENSG00000152382	TADA1	0.248	1.45E-02
ENSG00000132541	HRSP12	0.248	7.15E-03
ENSG00000188612	SUMO2	0.248	2.21E-06
ENSG00000136689	IL1RN	0.248	1.47E-04
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ENSG00000145860	RNF145	0.249	7.24E-06
ENSG00000139233	LLPH	0.249	2.11E-03
ENSG00000196139	AKR1C3	0.249	8.11E-03
ENSG00000133858	ZFC3H1	0.249	1.06E-05
ENSG00000197956	S100A6	0.249	9.95E-06
ENSG00000119729	RHOQ	0.249	7.35E-05
ENSG00000103342	GSPT1	0.249	4.85E-08
ENSG00000182704	TSKU	0.249	4.08E-06
ENSG00000164687	FABP5	0.249	4.74E-05
ENSG00000011295	TTC19	0.249	3.65E-05
ENSG00000186063	AIDA	0.249	2.67E-06
ENSG00000111775	COX6A1	0.249	2.40E-04
ENSG00000157456	CCNB2	0.249	1.31E-06
ENSG00000116455	WDR77	0.249	1.50E-03
ENSG00000139370	SLC15A4	0.250	4.56E-04
ENSG00000111641	NOP2	0.250	1.03E-06
ENSG00000242086	LINC00969	0.250	2.61E-03
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ENSG00000148411	NACC2	0.250	7.58E-04
ENSG00000104356	POP1	0.250	1.92E-04
ENSG00000105971	CAV2	0.251	7.81E-06
ENSG00000167088	SNRPD1	0.251	2.55E-06
ENSG00000166396	SERPINB7	0.251	1.03E-02
ENSG00000223572	CKMT1A	0.251	1.36E-03
ENSG00000182628	SKA2	0.251	3.06E-05
ENSG00000136026	CKAP4	0.251	2.73E-07
ENSG00000075914	EXOSC7	0.251	1.52E-03
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ENSG00000182512	GLRX5	0.252	2.04E-04
ENSG00000179010	MRFAP1	0.252	1.46E-07
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ENSG00000233016	SNHG7	0.252	1.45E-03
ENSG00000198467	TPM2	0.252	5.33E-08
ENSG00000116133	DHCR24	0.252	6.00E-09
ENSG00000167657	DAPK3	0.252	2.89E-05
ENSG00000105176	URI1	0.253	9.85E-06
ENSG00000125868	DSTN	0.253	1.36E-05
ENSG00000051523	CYBA	0.253	3.52E-03
ENSG00000087495	PHACTR3	0.253	2.44E-02
ENSG00000137691	C11orf70	0.253	2.32E-02
ENSG00000107949	BCCIP	0.253	9.17E-06
ENSG00000140157	NIPA2	0.253	7.65E-06
ENSG00000042445	RETSAT	0.253	5.78E-06
ENSG00000205542	TMSB4X	0.253	5.52E-08
ENSG00000167880	EVPL	0.253	5.04E-04
ENSG00000129968	ABHD17A	0.253	9.94E-05
ENSG00000101442	ACTR5	0.253	2.74E-03
ENSG00000060982	BCAT1	0.254	7.36E-05
ENSG00000053747	LAMA3	0.254	1.38E-06
ENSG00000169174	PCSK9	0.254	8.79E-05
ENSG00000130511	SSBP4	0.254	5.48E-03
ENSG00000167604	NFKBID	0.254	8.52E-03
ENSG00000177706	FAM20C	0.254	5.12E-04
ENSG00000105854	PON2	0.254	1.85E-05
ENSG00000070950	RAD18	0.254	7.06E-06
ENSG00000173915	USMG5	0.254	1.82E-05
ENSG00000144730	IL17RD	0.254	2.13E-02
ENSG00000152558	TMEM123	0.254	4.35E-06
ENSG00000178996	SNX18	0.254	1.17E-04
ENSG00000141759	TXNL4A	0.255	1.78E-05
ENSG00000100364	KIAA0930	0.255	3.44E-06
ENSG00000125388	GRK4	0.255	4.27E-02
ENSG00000112679	DUSP22	0.255	2.36E-04
ENSG00000087842	PIR	0.255	9.34E-03
ENSG00000133028	SCO1	0.255	6.22E-05
ENSG00000153558	FBXL2	0.255	3.65E-02
ENSG00000124541	RRP36	0.255	1.36E-05
ENSG00000100522	GNPNAT1	0.255	3.09E-05
ENSG00000183617	MRPL54	0.255	2.46E-02

ENSG00000166130	IKBIP	0.256	1.20E-04
ENSG00000198898	CAPZA2	0.256	4.82E-04
ENSG00000278129	ZNF8	0.256	3.28E-02
ENSG00000167193	CRK	0.256	9.38E-08
ENSG00000249915	PDCD6	0.256	8.51E-07
ENSG00000130826	DKC1	0.256	2.93E-07
ENSG00000115884	SDC1	0.256	4.03E-08
ENSG00000117528	ABCD3	0.256	7.34E-05
ENSG00000115598	IL1RL2	0.256	2.01E-02
ENSG00000233864	TTTY15	0.256	1.20E-02
ENSG00000100342	APOL1	0.257	2.39E-02
ENSG00000100442	FKBP3	0.257	3.01E-04
ENSG00000184110	EIF3C	0.257	1.37E-03
ENSG00000185163	DDX51	0.257	1.66E-03
ENSG00000143753	DEGS1	0.257	2.16E-06
ENSG00000171155	C1GALT1C1	0.258	1.20E-03
ENSG00000116005	PCYOX1	0.258	3.12E-06
ENSG00000153443	UBALD1	0.258	4.20E-04
ENSG00000184990	SIVA1	0.258	3.37E-04
ENSG00000139726	DENR	0.258	4.76E-07
ENSG00000138772	ANXA3	0.258	6.97E-08
ENSG00000137975	CLCA2	0.259	2.84E-03
ENSG00000196776	CD47	0.259	7.66E-05
ENSG00000100612	DHRS7	0.259	4.71E-06
ENSG00000149187	CELF1	0.259	2.99E-07
ENSG00000168569	TMEM223	0.259	7.04E-04
ENSG00000277443	MARCKS	0.260	2.25E-07
ENSG00000225697	SLC26A6	0.261	5.81E-05
ENSG00000092841	MYL6	0.261	5.54E-08
ENSG00000131174	COX7B	0.261	7.16E-06
ENSG00000177879	AP3S1	0.261	2.99E-07
ENSG00000148296	SURF6	0.261	1.71E-06
ENSG00000163220	S100A9	0.261	1.32E-02
ENSG00000112697	TMEM30A	0.261	2.47E-06
ENSG00000146054	TRIM7	0.261	2.09E-04
ENSG00000186222	BLOC1S4	0.261	1.45E-02
ENSG00000180354	MTURN	0.261	7.58E-05
ENSG00000168575	SLC20A2	0.262	3.23E-07
ENSG00000172115	CYCS	0.262	1.10E-05
ENSG00000132429	POPDC3	0.262	9.91E-03
ENSG00000163535	SGOL2	0.262	3.76E-05
ENSG00000146909	NOM1	0.262	2.79E-05
ENSG00000148908	RGS10	0.263	2.00E-03

ENSG00000148835	TAF5	0.263	4.32E-03
ENSG00000235162	C12orf75	0.263	1.07E-04
ENSG00000197312	DDI2	0.263	2.64E-07
ENSG00000167394	ZNF668	0.263	2.39E-02
ENSG00000184209	SNRNP35	0.264	1.11E-03
ENSG00000090376	IRAK3	0.264	8.67E-07
ENSG00000106028	SSBP1	0.264	1.82E-05
ENSG00000113558	SKP1	0.264	2.90E-06
ENSG00000178184	PARD6G	0.264	6.56E-04
ENSG00000170860	LSM3	0.264	7.21E-07
ENSG00000175550	DRAP1	0.264	1.49E-06
ENSG00000154518	ATP5G3	0.265	1.06E-06
ENSG00000065485	PDIA5	0.265	1.21E-04
ENSG00000104689	TNFRSF10A	0.265	1.90E-05
ENSG00000088832	FKBP1A	0.265	2.50E-07
ENSG00000115539	PDCL3	0.265	1.15E-04
ENSG00000114902	SPCS1	0.265	1.63E-06
ENSG00000164032	H2AFZ	0.265	3.86E-07
ENSG00000122068	FYTTD1	0.265	4.69E-07
ENSG00000068028	RASSF1	0.265	5.67E-05
ENSG00000166401	SERPINB8	0.266	2.16E-06
ENSG00000161800	RACGAP1	0.266	1.89E-07
ENSG00000164620	RELL2	0.266	5.16E-04
ENSG00000118242	MREG	0.266	6.00E-03
ENSG00000086189	DIMT1	0.266	5.54E-06
ENSG00000168116	KIAA1586	0.266	9.27E-03
ENSG00000160408	ST6GALNAC6	0.266	3.68E-04
ENSG00000052802	MSMO1	0.266	1.99E-06
ENSG00000143742	SRP9	0.266	4.15E-05
ENSG00000070831	CDC42	0.266	5.40E-07
ENSG00000132286	TIMM10B	0.266	7.55E-06
ENSG00000168040	FADD	0.267	7.60E-05
ENSG00000213186	TRIM59	0.267	1.29E-03
ENSG00000082153	BZW1	0.267	7.16E-08
ENSG00000109861	CTSC	0.267	7.49E-08
ENSG00000127947	PTPN12	0.267	1.34E-07
ENSG00000138134	STAMBPL1	0.268	2.69E-02
ENSG00000135823	STX6	0.268	5.02E-07
ENSG00000165655	ZNF503	0.268	1.87E-04
ENSG00000134954	ETS1	0.268	8.29E-08
ENSG00000172663	TMEM134	0.268	5.39E-03
ENSG00000131473	ACLY	0.268	8.52E-09
ENSG00000170468	C14orf169	0.268	3.32E-05

ENSG00000100941	PNN	0.268	6.44E-07
ENSG00000129473	BCL2L2	0.269	1.01E-03
ENSG00000168453	HR	0.269	5.68E-06
ENSG00000180957	PITPNB	0.269	6.05E-08
ENSG00000184752	NDUFA12	0.269	8.69E-06
ENSG00000269609	RPARP-AS1	0.270	1.09E-02
ENSG00000186594	MIR22HG	0.270	3.21E-04
ENSG00000100902	PSMA6	0.270	3.72E-02
ENSG00000100697	DICER1	0.270	5.67E-07
ENSG00000177868	SVBP	0.270	3.08E-02
ENSG00000126878	AIF1L	0.270	7.69E-03
ENSG00000171056	SOX7	0.271	8.44E-05
ENSG00000149089	APIP	0.271	9.02E-03
ENSG00000261150	EPPK1	0.271	4.76E-05
ENSG00000167721	TSR1	0.271	1.12E-07
ENSG00000110400	PVRL1	0.271	1.89E-07
ENSG00000135801	TAF5L	0.271	5.69E-06
ENSG00000186432	KPNA4	0.271	1.81E-07
ENSG00000110104	CCDC86	0.271	8.49E-07
ENSG00000013810	TACC3	0.272	1.50E-07
ENSG00000185361	TNFAIP8L1	0.272	1.14E-02
ENSG00000103855	CD276	0.272	2.49E-07
ENSG00000170855	TRIAP1	0.272	8.20E-04
ENSG00000136542	GALNT5	0.272	2.95E-03
ENSG00000160214	RRP1	0.272	3.42E-06
ENSG00000170144	HNRNPA3	0.273	3.89E-08
ENSG00000162704	ARPC5	0.273	2.59E-08
ENSG00000133393	FOPNL	0.273	4.39E-06
ENSG00000119862	LGALSL	0.273	1.87E-03
ENSG00000133477	FAM83F	0.274	7.66E-04
ENSG00000142686	C1orf216	0.274	5.36E-04
ENSG00000165724	ZMYND19	0.274	2.65E-05
ENSG00000159348	CYB5R1	0.274	4.04E-06
ENSG00000033627	ATP6V0A1	0.274	3.64E-06
ENSG00000205352	PRR13	0.274	7.23E-04
ENSG00000144136	SLC20A1	0.275	2.53E-08
ENSG00000177051	FBXO46	0.275	1.58E-04
ENSG00000197024	ZNF398	0.275	4.42E-05
ENSG00000189334	S100A14	0.275	4.13E-09
ENSG00000166170	BAG5	0.276	1.14E-07
ENSG00000163932	PRKCD	0.276	1.33E-05
ENSG00000108848	LUC7L3	0.276	8.34E-07
ENSG00000186603	HPDL	0.276	1.97E-03

ENSG00000161547	SRSF2	0.276	3.36E-07
ENSG00000141994	DUS3L	0.277	1.14E-04
ENSG00000070087	PFN2	0.277	3.40E-06
ENSG00000235194	PPP1R3E	0.277	6.78E-03
ENSG00000102317	RBM3	0.277	5.75E-09
ENSG00000114999	TTL	0.277	6.04E-08
ENSG00000174695	TMEM167A	0.278	1.48E-06
ENSG00000103126	AXIN1	0.278	2.37E-06
ENSG00000103061	SLC7A6OS	0.278	4.29E-05
ENSG00000023445	BIRC3	0.279	6.26E-05
ENSG00000186193	SAPCD2	0.279	2.27E-04
ENSG00000176014	TUBB6	0.279	3.89E-08
ENSG00000178567	EPM2AIP1	0.279	8.04E-04
ENSG00000153885	KCTD15	0.279	1.29E-05
ENSG00000104892	KLC3	0.279	1.61E-03
ENSG00000139291	TMEM19	0.279	3.27E-03
ENSG00000138382	METTL5	0.280	2.59E-04
ENSG00000037474	NSUN2	0.280	1.07E-08
ENSG00000091527	CDV3	0.281	1.29E-08
ENSG00000181751	C5orf30	0.281	9.43E-04
ENSG00000117877	CD3EAP	0.281	1.05E-06
ENSG00000100836	PABPN1	0.281	2.72E-06
ENSG00000166949	SMAD3	0.282	1.13E-07
ENSG00000136003	ISCU	0.282	6.59E-06
ENSG00000146904	EPHA1	0.282	1.37E-04
ENSG00000181019	NQO1	0.283	2.93E-06
ENSG00000159110	IFNAR2	0.283	3.77E-03
ENSG00000198692	EIF1AY	0.283	1.71E-04
ENSG00000119335	SET	0.283	2.16E-09
ENSG00000146802	TMEM168	0.284	1.40E-03
ENSG00000176731	C8orf59	0.284	3.81E-05
ENSG00000075624	ACTB	0.284	1.85E-09
ENSG00000072042	RDH11	0.284	5.84E-08
ENSG00000144746	ARL6IP5	0.284	9.21E-07
ENSG00000100285	NEFH	0.284	5.29E-07
ENSG00000144034	TPRKB	0.285	7.37E-06
ENSG00000163041	H3F3A	0.285	1.99E-08
ENSG00000223705	NSUN5P1	0.285	1.92E-03
ENSG00000153130	SCOC	0.285	2.43E-04
ENSG00000106355	LSM5	0.286	2.15E-04
ENSG00000147155	EBP	0.286	2.04E-07
ENSG00000149503	INCENP	0.286	7.89E-08
ENSG00000169641	LUZP1	0.286	1.86E-08

ENSG00000129625	REEP5	0.286	1.32E-07
ENSG00000008394	MGST1	0.287	1.66E-05
ENSG00000172893	DHCR7	0.287	3.10E-06
ENSG00000197457	STMN3	0.287	1.84E-03
ENSG00000107937	GTPBP4	0.288	3.71E-07
ENSG00000215301	DDX3X	0.288	9.23E-10
ENSG00000197119	SLC25A29	0.288	8.62E-04
ENSG00000174684	B4GAT1	0.288	7.69E-03
ENSG00000075618	FSCN1	0.288	6.44E-07
ENSG00000188229	TUBB4B	0.289	1.24E-08
ENSG00000143401	ANP32E	0.289	8.38E-07
ENSG00000176903	PNMA1	0.289	4.65E-07
ENSG00000172428	MYEOV2	0.289	2.37E-03
ENSG00000198863	RUNDC1	0.290	2.60E-05
ENSG00000100092	SH3BP1	0.290	9.28E-07
ENSG00000204899	MZT1	0.290	3.17E-03
ENSG00000228253	MT-ATP8	0.290	2.72E-04
ENSG00000115652	UXS1	0.290	1.67E-05
ENSG00000137563	GGH	0.291	1.25E-04
ENSG00000151632	AKR1C2	0.291	6.52E-03
ENSG00000155115	GTF3C6	0.291	1.02E-04
ENSG00000135932	CAB39	0.291	3.68E-08
ENSG00000075415	SLC25A3	0.291	2.48E-08
ENSG00000099625	CBARP	0.292	1.41E-02
ENSG00000163811	WDR43	0.292	5.71E-08
ENSG00000184675	AMER1	0.292	1.09E-03
ENSG00000143499	SMYD2	0.293	8.69E-06
ENSG00000119185	ITGB1BP1	0.293	5.95E-07
ENSG00000184007	PTP4A2	0.293	4.75E-08
ENSG00000197385	ZNF860	0.293	6.42E-03
ENSG00000120913	PDLIM2	0.294	1.28E-03
ENSG00000160113	NR2F6	0.294	2.91E-05
ENSG00000131188	PRR7	0.294	3.07E-02
ENSG00000145337	PYURF	0.294	2.74E-04
ENSG00000137492	PRKRIR	0.295	1.26E-07
ENSG00000123908	AGO2	0.295	8.75E-09
ENSG00000163162	RNF149	0.295	3.83E-06
ENSG00000151247	EIF4E	0.295	5.43E-06
ENSG00000228672	PROB1	0.296	2.72E-05
ENSG00000177469	PTRF	0.296	1.13E-08
ENSG00000011465	DCN	0.296	4.30E-02
ENSG00000063660	GPC1	0.296	3.49E-07
ENSG00000155438	NIFK	0.296	7.70E-06

ENSG00000155085	AK9	0.296	3.07E-02
ENSG00000164976	KIAA1161	0.297	2.17E-06
ENSG00000143224	PPOX	0.298	1.42E-02
ENSG00000166886	NAB2	0.298	8.97E-07
ENSG00000178934	LGALS7B	0.298	3.67E-02
ENSG00000115641	FHL2	0.298	5.57E-07
ENSG00000159840	ZYX	0.298	3.90E-08
ENSG00000176624	MEX3C	0.298	6.42E-07
ENSG00000100473	COCH	0.299	4.48E-03
ENSG00000073712	FERMT2	0.299	9.97E-08
ENSG00000180822	PSMG4	0.300	2.08E-03
ENSG00000182004	SNRPE	0.300	7.39E-06
ENSG00000142961	MOB3C	0.300	4.15E-05
ENSG00000176092	AIM1L	0.301	9.76E-04
ENSG00000145736	GTF2H2	0.301	1.91E-02
ENSG00000172339	ALG14	0.301	1.26E-02
ENSG00000152291	TGOLN2	0.301	2.16E-09
ENSG00000154065	ANKRD29	0.301	3.49E-03
ENSG00000115128	SF3B6	0.302	2.91E-07
ENSG00000163032	VSNL1	0.302	3.20E-02
ENSG00000026103	FAS	0.302	1.91E-05
ENSG00000221968	FADS3	0.303	7.52E-06
ENSG00000183742	MACC1	0.303	8.57E-03
ENSG00000158315	RHBDL2	0.303	2.01E-02
ENSG00000185753	CXorf38	0.304	1.47E-04
ENSG00000134590	FAM127A	0.304	1.24E-05
ENSG00000213347	MXD3	0.304	4.45E-03
ENSG00000187134	AKR1C1	0.305	1.26E-03
ENSG00000008282	SYPL1	0.305	7.66E-06
ENSG00000174607	UGT8	0.306	2.42E-03
ENSG00000272325	NUDT3	0.306	3.84E-07
ENSG00000177602	GSG2	0.306	8.85E-06
ENSG00000148291	SURF2	0.306	6.30E-06
ENSG00000119640	ACYP1	0.306	3.20E-02
ENSG00000165732	DDX21	0.306	3.86E-10
ENSG00000136950	ARPC5L	0.306	5.35E-07
ENSG00000128245	YWHAH	0.307	1.19E-08
ENSG00000188206	HNRNPU-AS1	0.307	6.18E-04
ENSG00000230937	MIR205HG	0.307	1.67E-08
ENSG00000010278	CD9	0.308	1.36E-04
ENSG00000175040	CHST2	0.308	2.48E-03
ENSG00000089685	BIRC5	0.308	3.29E-08
ENSG00000173432	SAA1	0.309	3.54E-07

ENSG00000130827	PLXNA3	0.309	2.66E-05
ENSG00000169926	KLF13	0.309	3.48E-08
ENSG00000140465	CYP1A1	0.309	1.65E-03
ENSG00000107614	TRDMT1	0.309	3.36E-02
ENSG00000099875	MKNK2	0.310	1.58E-07
ENSG00000015475	BID	0.310	1.74E-03
ENSG00000176387	HSD11B2	0.310	4.83E-02
ENSG00000218739	CEBPZOS	0.310	6.44E-07
ENSG00000185499	MUC1	0.311	1.24E-05
ENSG00000095951	HIVEP1	0.311	1.04E-07
ENSG00000104756	KCTD9	0.311	3.32E-08
ENSG00000270170	NCBP2-AS2	0.311	3.40E-04
ENSG00000100528	CNIH1	0.311	9.81E-07
ENSG00000151689	INPP1	0.311	3.63E-06
ENSG00000132680	KIAA0907	0.311	2.48E-06
ENSG00000167565	SERTAD3	0.311	7.68E-05
ENSG00000110042	DTX4	0.311	6.59E-06
ENSG00000138385	SSB	0.311	1.77E-03
ENSG00000188895	MSL1	0.312	1.00E-08
ENSG00000169679	BUB1	0.312	9.63E-09
ENSG00000035141	FAM136A	0.313	2.96E-07
ENSG00000161405	IKZF3	0.314	2.70E-03
ENSG00000198727	MT-CYB	0.314	1.05E-08
ENSG00000050393	MCUR1	0.314	7.56E-07
ENSG00000064547	LPAR2	0.314	4.81E-03
ENSG00000198431	TXNRD1	0.314	1.34E-07
ENSG00000167397	VKORC1	0.314	3.47E-03
ENSG00000048162	NOP16	0.315	1.69E-07
ENSG00000164934	DCAF13	0.315	3.88E-06
ENSG00000108106	UBE2S	0.315	8.14E-07
ENSG00000078269	SYNJ2	0.315	9.47E-06
ENSG00000176170	SPHK1	0.316	2.94E-06
ENSG00000132463	GRSF1	0.316	5.97E-07
ENSG00000127334	DYRK2	0.316	1.49E-05
ENSG00000247077	PGAM5	0.317	4.35E-07
ENSG00000170779	CDCA4	0.317	4.96E-08
ENSG00000023572	GLRX2	0.317	1.14E-03
ENSG00000100526	CDKN3	0.317	4.55E-06
ENSG00000162433	AK4	0.317	4.13E-08
ENSG00000178409	BEND3	0.318	2.59E-04
ENSG00000114503	NCBP2	0.319	1.12E-07
ENSG00000104131	EIF3J	0.319	4.85E-09
ENSG00000143933	CALM2	0.319	3.76E-07

ENSG00000152147	GEMIN6	0.320	2.88E-04
ENSG00000160712	IL6R	0.321	3.17E-07
ENSG00000085415	SEH1L	0.321	3.09E-07
ENSG00000187961	KLHL17	0.321	2.50E-04
ENSG00000213853	EMP2	0.321	3.42E-08
ENSG00000160685	ZBTB7B	0.321	3.49E-06
ENSG00000157045	NTAN1	0.322	5.84E-06
ENSG00000145386	CCNA2	0.322	4.10E-08
ENSG00000170684	ZNF296	0.322	5.23E-03
ENSG00000198840	MT-ND3	0.322	2.98E-11
ENSG00000183347	GBP6	0.323	4.49E-02
ENSG00000126787	DLGAP5	0.323	1.34E-07
ENSG00000163462	TRIM46	0.323	1.55E-02
ENSG00000165996	HACD1	0.324	1.43E-03
ENSG00000138180	CEP55	0.324	1.09E-08
ENSG00000131747	TOP2A	0.325	3.65E-10
ENSG00000161970	RPL26	0.325	7.90E-06
ENSG00000173894	CBX2	0.326	6.01E-03
ENSG00000129128	SPCS3	0.326	7.52E-09
ENSG00000103966	EHD4	0.327	4.90E-08
ENSG00000081870	HSPB11	0.327	2.72E-06
ENSG00000166923	GREM1	0.328	2.38E-07
ENSG00000136802	LRRC8A	0.328	6.41E-09
ENSG00000162377	COA7	0.329	3.74E-07
ENSG00000206073	SERPINB4	0.329	2.58E-02
ENSG00000181830	SLC35C1	0.330	3.37E-06
ENSG00000144451	SPAG16	0.330	4.53E-03
ENSG00000122565	CBX3	0.331	6.54E-09
ENSG00000119812	FAM98A	0.331	9.50E-08
ENSG00000265681	RPL17	0.331	3.19E-03
ENSG00000126822	PLEKHG3	0.332	4.62E-09
ENSG00000160050	CCDC28B	0.332	2.72E-02
ENSG00000162408	NOL9	0.332	1.16E-05
ENSG00000143546	S100A8	0.332	3.45E-02
ENSG00000171425	ZNF581	0.333	8.87E-04
ENSG00000030110	BAK1	0.334	8.93E-08
ENSG00000104783	KCNN4	0.336	3.99E-06
ENSG00000128191	DGCR8	0.337	1.75E-07
ENSG00000105514	RAB3D	0.337	3.72E-06
ENSG00000140905	GCSH	0.338	1.38E-04
ENSG00000186088	GSAP	0.338	3.28E-04
ENSG00000197451	HNRNPAB	0.338	5.60E-11
ENSG00000123975	CKS2	0.339	1.10E-07

ENSG00000100201	DDX17	0.339	1.99E-09
ENSG00000036257	CUL3	0.339	8.16E-08
ENSG00000159166	LAD1	0.339	1.13E-09
ENSG00000198668	CALM1	0.340	2.33E-09
ENSG00000089916	GPATCH2L	0.340	4.06E-08
ENSG00000143315	PIGM	0.340	7.93E-04
ENSG00000115091	ACTR3	0.340	2.84E-08
ENSG00000111665	CDCA3	0.341	5.61E-07
ENSG00000163597	SNHG16	0.341	9.22E-08
ENSG00000203667	COX20	0.341	5.22E-07
ENSG00000111696	NT5DC3	0.342	2.57E-05
ENSG00000178761	FAM219B	0.344	6.48E-06
ENSG00000185339	TCN2	0.344	2.13E-02
ENSG00000244462	RBM12	0.344	1.57E-08
ENSG00000186132	C2orf76	0.344	1.15E-02
ENSG00000112029	FBXO5	0.346	5.73E-08
ENSG00000137124	ALDH1B1	0.346	3.29E-07
ENSG00000101361	NOP56	0.347	3.30E-10
ENSG00000132481	TRIM47	0.347	1.92E-07
ENSG00000006634	DBF4	0.347	2.94E-07
ENSG00000173218	VANGL1	0.348	4.61E-09
ENSG00000159593	NAE1	0.348	4.01E-07
ENSG00000231607	DLEU2	0.348	2.21E-03
ENSG00000068078	FGFR3	0.349	1.68E-06
ENSG00000154359	LONRF1	0.349	2.72E-03
ENSG00000080561	MID2	0.350	2.74E-04
ENSG00000184207	PGP	0.350	1.56E-05
ENSG00000186871	ERCC6L	0.350	4.85E-06
ENSG00000170545	SMAGP	0.351	8.38E-06
ENSG00000273344	PAXIP1-AS1	0.351	5.08E-02
ENSG00000179409	GEMIN4	0.351	1.14E-07
ENSG00000172301	COPRS	0.351	9.80E-05
ENSG00000140367	UBE2Q2	0.352	5.56E-07
ENSG00000169607	CKAP2L	0.353	1.77E-09
ENSG00000169019	COMMD8	0.353	5.25E-03
ENSG00000135763	URB2	0.354	9.11E-07
ENSG00000237649	KIFC1	0.354	1.35E-09
ENSG00000136997	MYC	0.354	3.87E-08
ENSG00000070961	ATP2B1	0.355	5.78E-08
ENSG00000143387	CTSK	0.355	2.32E-02
ENSG00000118939	UCHL3	0.356	2.19E-02
ENSG00000246695	RASSF8-AS1	0.357	3.01E-02
ENSG00000124942	AHNAK	0.358	7.12E-10

ENSG00000171453	POLR1C	0.359	2.43E-05
ENSG00000102030	NAA10	0.359	4.20E-04
ENSG00000179886	TIGD5	0.360	3.55E-03
ENSG00000174173	TRMT10C	0.361	9.41E-08
ENSG00000057149	SERPINB3	0.362	2.70E-05
ENSG00000066279	ASPM	0.362	2.16E-09
ENSG00000155189	AGPAT5	0.363	7.35E-07
ENSG00000169018	FEM1B	0.363	1.73E-08
ENSG00000117602	RCAN3	0.364	6.03E-06
ENSG00000234771	SLC25A25-AS1	0.364	1.74E-03
ENSG00000114993	RTKN	0.364	2.48E-08
ENSG00000103044	HAS3	0.365	4.58E-07
ENSG00000183876	ARSI	0.366	5.46E-05
ENSG00000165233	CARD19	0.366	5.82E-06
ENSG00000104549	SQLE	0.366	1.49E-10
ENSG00000132467	UTP3	0.368	2.14E-08
ENSG00000123505	AMD1	0.369	1.00E-09
ENSG00000085063	CD59	0.370	3.86E-10
ENSG00000213088	ACKR1	0.370	1.42E-04
ENSG00000141391	PRELID3A	0.371	2.48E-03
ENSG00000166619	BLCAP	0.371	1.48E-09
ENSG00000172840	PDP2	0.372	1.28E-06
ENSG00000181873	IBA57	0.372	3.88E-05
ENSG00000162769	FLVCR1	0.373	5.11E-06
ENSG00000107443	CCNJ	0.373	8.76E-06
ENSG00000244165	P2RY11	0.374	2.57E-03
ENSG00000064666	CNN2	0.375	4.61E-10
ENSG00000177551	NHLH2	0.375	3.17E-02
ENSG00000225630	MTND2P28	0.375	1.23E-03
ENSG00000115266	APC2	0.376	3.73E-04
ENSG00000057294	PKP2	0.376	2.00E-10
ENSG00000188910	GJB3	0.377	1.63E-10
ENSG00000100478	AP4S1	0.379	9.66E-03
ENSG00000116815	CD58	0.379	7.59E-07
ENSG00000164163	ABCE1	0.380	8.82E-10
ENSG00000175063	UBE2C	0.382	2.11E-10
ENSG00000177225	PDDC1	0.384	9.42E-06
ENSG00000198618	PPIAP22	0.384	1.90E-02
ENSG00000163463	KRTCAP2	0.384	3.30E-02
ENSG00000184661	CDCA2	0.386	7.01E-09
ENSG00000182585	EPGN	0.386	1.29E-03
ENSG00000198542	ITGBL1	0.387	8.47E-04
ENSG00000164626	KCNK5	0.387	5.02E-04

ENSG00000119698	PPP4R4	0.388	1.38E-04
ENSG00000147324	MFHAS1	0.388	1.38E-08
ENSG00000117525	F3	0.388	7.45E-11
ENSG00000276600	RAB7B	0.389	8.69E-06
ENSG00000182310	SPACA6P	0.389	2.31E-02
ENSG00000128594	LRRC4	0.390	1.78E-02
ENSG00000165272	AQP3	0.390	5.66E-06
ENSG00000163110	PDLIM5	0.391	6.66E-10
ENSG00000168118	RAB4A	0.391	1.15E-06
ENSG00000143847	PPFIA4	0.393	2.95E-03
ENSG00000075218	GTSE1	0.393	9.12E-08
ENSG00000161960	EIF4A1	0.393	1.61E-02
ENSG00000179593	ALOX15B	0.393	1.35E-02
ENSG00000185033	SEMA4B	0.394	3.91E-10
ENSG00000196371	FUT4	0.396	2.62E-04
ENSG00000079931	MOXD1	0.396	3.72E-02
ENSG00000170458	CD14	0.397	2.55E-04
ENSG00000164096	C4orf3	0.397	7.12E-09
ENSG00000134690	CDCA8	0.398	9.31E-09
ENSG00000160201	U2AF1	0.399	5.92E-03
ENSG00000130590	SAMD10	0.400	1.67E-03
ENSG00000196968	FUT11	0.405	1.58E-06
ENSG00000197162	ZNF785	0.405	2.96E-04
ENSG00000198934	MAGEE1	0.406	2.67E-02
ENSG00000100416	TRMU	0.407	2.78E-07
ENSG00000239911	PRKAG2-AS1	0.408	4.79E-02
ENSG00000159231	CBR3	0.408	1.04E-02
ENSG00000149948	HMGA2	0.409	2.12E-12
ENSG00000103264	FBXO31	0.410	3.49E-07
ENSG00000214194	LINC00998	0.410	7.09E-06
ENSG00000146858	ZC3HAV1L	0.410	1.04E-02
ENSG00000186480	INSIG1	0.411	9.36E-10
ENSG00000158122	AAED1	0.411	3.95E-06
ENSG00000148773	MKI67	0.411	2.12E-12
ENSG00000186185	KIF18B	0.411	6.76E-09
ENSG00000168758	SEMA4C	0.413	1.21E-06
ENSG00000214029	ZNF891	0.413	6.99E-03
ENSG00000171476	HOPX	0.414	3.50E-02
ENSG00000197847	SLC22A20	0.415	2.59E-02
ENSG00000113430	IRX4	0.415	2.10E-03
ENSG00000035403	VCL	0.417	1.98E-12
ENSG00000179431	FJX1	0.417	2.32E-05
ENSG00000100711	ZFYVE21	0.418	2.18E-06

ENSG00000163659	TIPARP	0.422	7.58E-11
ENSG00000103067	ESRP2	0.422	3.94E-09
ENSG00000113368	LMNB1	0.422	1.96E-11
ENSG00000115163	CENPA	0.423	5.14E-07
ENSG00000146386	ABRACL	0.423	1.27E-07
ENSG00000163701	IL17RE	0.426	5.59E-03
ENSG00000188505	NCCRP1	0.426	3.71E-02
ENSG00000071575	TRIB2	0.426	3.93E-06
ENSG00000215012	C22orf29	0.427	6.99E-07
ENSG00000170540	ARL6IP1	0.427	8.15E-09
ENSG00000171346	KRT15	0.427	1.13E-03
ENSG00000100065	CARD10	0.428	2.48E-08
ENSG00000159208	CIART	0.428	7.26E-04
ENSG00000112984	KIF20A	0.429	3.45E-11
ENSG00000054179	ENTPD2	0.430	4.90E-05
ENSG00000253716	MINCR	0.431	1.62E-02
ENSG00000146112	PPP1R18	0.431	3.44E-12
ENSG00000175768	TOMM5	0.432	5.50E-03
ENSG00000172366	FAM195A	0.432	5.28E-04
ENSG00000157111	TMEM171	0.433	2.39E-02
ENSG00000210100	MT-TI	0.433	2.91E-02
ENSG00000066248	NGEF	0.433	5.08E-02
ENSG00000174939	ASPHD1	0.433	8.04E-03
ENSG00000165474	GJB2	0.435	7.64E-10
ENSG00000173166	RAPH1	0.435	2.01E-11
ENSG00000180739	S1PR5	0.436	5.09E-04
ENSG00000149798	CDC42EP2	0.436	2.01E-08
ENSG00000167508	MVD	0.437	1.05E-09
ENSG00000198938	MT-CO3	0.437	1.99E-10
ENSG00000197362	ZNF786	0.439	2.01E-04
ENSG00000161647	MPP3	0.440	1.12E-04
ENSG00000155846	PPARGC1B	0.440	2.37E-07
ENSG00000155903	RASA2	0.441	2.06E-07
ENSG00000215788	TNFRSF25	0.442	3.17E-07
ENSG00000189433	GJB4	0.442	5.22E-03
ENSG00000138778	CENPE	0.443	1.08E-10
ENSG00000197114	ZGPAT	0.445	9.05E-04
ENSG00000040199	PHLPP2	0.446	3.40E-08
ENSG00000167695	FAM57A	0.448	9.25E-11
ENSG00000143878	RHOB	0.450	2.77E-06
ENSG00000142634	EFHD2	0.450	1.24E-10
ENSG00000198826	ARHGAP11A	0.451	3.75E-11
ENSG00000106003	LFNG	0.453	7.78E-03

ENSG00000167460	TPM4	0.455	2.06E-14
ENSG00000173933	RBM4	0.455	4.48E-03
ENSG00000129195	FAM64A	0.455	1.91E-07
ENSG00000166289	PLEKHF1	0.456	1.99E-02
ENSG00000174307	PHLDA3	0.456	4.39E-07
ENSG00000143815	LBR	0.456	2.17E-09
ENSG00000247516	MIR4458HG	0.461	5.07E-03
ENSG00000177576	C18orf32	0.464	4.09E-02
ENSG00000140534	TICRR	0.465	2.69E-10
ENSG00000163814	CDCP1	0.465	1.83E-13
ENSG00000132603	NIP7	0.467	5.28E-10
ENSG00000189377	CXCL17	0.469	4.07E-02
ENSG00000149591	TAGLN	0.470	1.21E-07
ENSG00000184009	ACTG1	0.470	9.76E-14
ENSG00000239779	WBP1	0.470	1.34E-02
ENSG00000157514	TSC22D3	0.473	4.60E-11
ENSG00000182325	FBXL6	0.476	1.67E-05
ENSG00000198894	CIPC	0.477	8.24E-06
ENSG00000137807	KIF23	0.477	1.13E-12
ENSG00000154548	SRSF12	0.479	2.17E-02
ENSG00000203761	MSTO2P	0.481	2.02E-02
ENSG00000277072	STAG3L2	0.481	7.36E-04
ENSG00000182481	KPNA2	0.482	5.06E-14
ENSG00000134057	CCNB1	0.484	5.56E-11
ENSG00000166851	PLK1	0.487	2.29E-11
ENSG00000087586	AURKA	0.487	4.55E-12
ENSG00000184602	SNN	0.489	1.10E-07
ENSG00000155367	PPM1J	0.490	3.56E-03
ENSG00000124102	PI3	0.490	1.29E-06
ENSG00000188368	PRR19	0.495	2.28E-02
ENSG00000124802	EEF1E1	0.496	3.55E-04
ENSG00000122644	ARL4A	0.501	9.91E-08
ENSG00000040633	PHF23	0.502	5.38E-10
ENSG00000163735	CXCL5	0.502	3.49E-02
ENSG00000115841	RMDN2	0.505	1.27E-02
ENSG00000124593	PRICKLE4	0.505	7.55E-03
ENSG00000241852	C8orf58	0.506	4.87E-05
ENSG00000125775	SDCBP2	0.507	1.65E-06
ENSG00000080947	CROCCP3	0.508	4.06E-02
ENSG00000134339	SAA2	0.509	2.47E-03
ENSG00000184254	ALDH1A3	0.509	1.03E-12
ENSG00000115507	OTX1	0.510	7.20E-06
ENSG00000118263	KLF7	0.512	1.51E-14

ENSG00000112658	SRF	0.512	1.17E-09
ENSG00000261326	LINC01355	0.512	1.03E-02
ENSG00000188613	NANOS1	0.513	2.22E-03
ENSG00000168556	ING2	0.515	1.76E-08
ENSG00000164086	DUSP7	0.518	1.25E-13
ENSG00000137440	FGFBP1	0.519	2.43E-13
ENSG00000176244	ACBD7	0.520	2.58E-02
ENSG00000178074	C2orf69	0.521	1.48E-07
ENSG00000269858	EGLN2	0.522	1.27E-04
ENSG00000197191	CYSRT1	0.529	8.43E-03
ENSG00000188483	IER5L	0.530	2.39E-06
ENSG00000198331	HYLS1	0.530	2.85E-08
ENSG00000113161	HMGCR	0.532	5.18E-14
ENSG00000101447	FAM83D	0.533	1.65E-11
ENSG00000248019	FAM13A-AS1	0.539	3.00E-02
ENSG00000247092	SNHG10	0.540	1.88E-02
ENSG00000130208	APOC1	0.554	2.19E-02
ENSG00000105732	ZNF574	0.554	1.80E-08
ENSG00000104998	IL27RA	0.556	3.21E-05
ENSG00000179041	RRS1	0.558	6.61E-10
ENSG00000203896	LIME1	0.561	2.69E-03
ENSG00000178951	ZBTB7A	0.564	6.84E-12
ENSG00000145358	DDIT4L	0.566	2.67E-02
ENSG00000145423	SFRP2	0.571	5.01E-03
ENSG00000246228	CASC8	0.571	1.66E-02
ENSG00000228109	MFI2-AS1	0.573	1.12E-02
ENSG00000181284	TMEM102	0.576	6.75E-06
ENSG00000244687	UBE2V1	0.579	3.30E-03
ENSG00000050438	SLC4A8	0.582	2.57E-02
ENSG00000262814	MRPL12	0.583	1.11E-03
ENSG00000210195	MT-TT	0.584	3.36E-03
ENSG00000185614	FAM212A	0.584	4.19E-04
ENSG00000089692	LAG3	0.587	1.28E-02
ENSG00000134222	PSRC1	0.589	9.45E-11
ENSG00000210196	MT-TP	0.593	1.79E-03
ENSG00000183691	NOG	0.593	5.55E-03
ENSG00000171757	LRRC34	0.597	1.06E-02
ENSG00000117228	GBP1	0.601	2.76E-10
ENSG00000130810	PPAN	0.606	3.82E-04
ENSG00000123485	HJURP	0.606	1.51E-14
ENSG00000241794	SPRR2A	0.607	1.88E-02
ENSG00000203727	SAMD5	0.611	1.97E-03
ENSG00000141542	RAB40B	0.615	7.65E-06

ENSG00000111252	SH2B3	0.616	9.11E-13
ENSG00000002587	HS3ST1	0.622	9.80E-03
ENSG00000136167	LCP1	0.623	3.19E-05
ENSG00000199753	SNORD104	0.625	2.01E-02
ENSG00000138675	FGF5	0.626	1.87E-05
ENSG00000169991	IFFO2	0.627	9.08E-14
ENSG00000237883	DGUOK-AS1	0.635	4.48E-03
ENSG00000197632	SERPINB2	0.639	1.26E-14
ENSG00000102760	RGCC	0.640	3.77E-03
ENSG00000174353	STAG3L3	0.650	1.61E-06
ENSG00000189184	PCDH18	0.651	1.23E-02
ENSG00000170454	KRT75	0.655	1.27E-04
ENSG00000246334	PRR7-AS1	0.666	2.96E-02
ENSG00000178127	NDUFV2	0.668	4.30E-03
ENSG00000168906	MAT2A	0.672	2.45E-15
ENSG00000163082	SGPP2	0.683	7.03E-07
ENSG00000139278	GLIPR1	0.684	3.55E-11
ENSG00000108244	KRT23	0.684	3.85E-04
ENSG00000197182	MIRLET7BHG	0.687	1.72E-04
ENSG00000162063	CCNF	0.691	2.50E-13
ENSG00000240053	LY6G5B	0.692	9.48E-04
ENSG00000115756	HPCAL1	0.701	2.38E-10
ENSG00000151006	PRSS53	0.703	2.71E-03
ENSG00000228727	SAPCD1	0.704	1.82E-02
ENSG00000231991	ANXA2P2	0.713	2.60E-02
ENSG00000184731	FAM110C	0.727	1.22E-11
ENSG00000100311	PDGFB	0.732	7.17E-06
ENSG00000070444	MNT	0.738	6.46E-14
ENSG00000100060	MFNG	0.741	2.61E-05
ENSG00000170425	ADORA2B	0.747	1.12E-10
ENSG00000170961	HAS2	0.756	7.19E-07
ENSG00000147437	GNRH1	0.762	4.38E-03
ENSG00000136688	IL36G	0.770	4.32E-03
ENSG00000125798	FOXA2	0.771	3.41E-08
ENSG00000198744	MTCO3P12	0.772	5.95E-03
ENSG00000247095	MIR210HG	0.783	5.14E-07
ENSG00000204316	MRPL38	0.784	1.65E-02
ENSG00000197461	PDGFA	0.787	8.16E-12
ENSG00000137462	TLR2	0.800	9.29E-12
ENSG00000111664	GNB3	0.813	2.74E-05
ENSG00000198695	MT-ND6	0.815	1.03E-12
ENSG00000179820	MYADM	0.826	4.86E-14
ENSG00000242125	SNHG3	0.839	3.67E-12

ENSG00000116273	PHF13	0.864	1.10E-14
ENSG00000127528	KLF2	0.868	1.31E-04
ENSG00000138061	CYP1B1	0.874	2.05E-18
ENSG00000241404	EGFL8	0.879	1.98E-03
ENSG00000062282	DGAT2	0.883	8.48E-08
ENSG00000157734	SNX22	0.888	4.19E-02
ENSG00000210151	MT-TS1	0.895	2.97E-04
ENSG00000183426	NPIPA1	0.928	2.44E-05
ENSG00000182685	BRICD5	0.960	2.21E-05
ENSG00000249992	TMEM158	1.004	9.53E-05
ENSG00000173530	TNFRSF10D	1.012	1.02E-17
ENSG00000140451	PIF1	1.040	1.08E-10
ENSG00000281398	SNHG4	1.056	1.76E-08
ENSG00000134668	SPOCD1	1.152	1.99E-09
ENSG00000212724	KRTAP2-3	1.188	2.00E-05
ENSG00000200087	SNORA73B	1.203	2.90E-03
ENSG00000210127	MT-TA	1.231	2.60E-05
ENSG00000210107	MT-TQ	1.312	2.39E-08
ENSG00000165507	C10orf10	2.579	3.03E-14

Table A3. List of differentially expressed genes (DEGs) control compared to 5U rhPON2

Ensembl	Symbol	log_2FC	P.Val
ENSG00000127528	KLF2	2.150	8.65E-09
ENSG00000165507	C10orf10	1.533	4.92E-10
ENSG00000167995	BEST1	1.513	4.84E-04
ENSG00000203865	ATP1A1-AS1	1.283	2.81E-03
ENSG00000218537	MIF-AS1	1.221	2.83E-04
ENSG00000120738	EGR1	1.217	3.03E-17
ENSG00000157734	SNX22	1.202	4.92E-02
ENSG00000172803	SNX32	1.201	9.13E-03
ENSG00000232810	TNF	1.185	2.63E-02
ENSG00000089692	LAG3	1.169	3.40E-04
ENSG00000219891	ZSCAN12P1	1.032	2.38E-04
ENSG00000197279	ZNF165	1.026	7.83E-09
ENSG00000197580	BCO2	0.956	5.98E-03
ENSG00000123485	HJURP	0.919	2.37E-17
ENSG00000171522	PTGER4	0.918	5.22E-09
ENSG00000132522	GPS2	0.911	1.24E-02
ENSG00000140451	PIF1	0.888	7.53E-09
ENSG00000101306	MYLK2	0.878	3.87E-04
ENSG00000139354	GAS2L3	0.851	8.43E-12
ENSG00000186480	INSIG1	0.848	2.51E-15
ENSG00000180953	ST20	0.823	9.48E-03
ENSG00000087074	PPP1R15A	0.766	2.55E-13
ENSG00000182600	C2orf82	0.765	1.59E-02
ENSG00000160223	ICOSLG	0.762	3.87E-04
ENSG00000130052	STARD8	0.761	4.24E-02
ENSG00000123870	ZNF137P	0.757	1.65E-02
ENSG00000162063	CCNF	0.753	2.01E-13
ENSG00000138778	CENPE	0.752	9.91E-15
ENSG00000134222	PSRC1	0.734	1.04E-11
ENSG00000166483	WEE1	0.734	1.88E-10
ENSG00000140534	TICRR	0.728	2.55E-13
ENSG00000134668	SPOCD1	0.724	2.89E-05
ENSG00000235552	RPL6P27	0.719	4.94E-02
ENSG00000101447	FAM83D	0.713	2.01E-13
ENSG00000165494	PCF11	0.694	1.19E-14
ENSG00000121621	KIF18A	0.682	8.96E-11

ENSG00000172818	OVOL1	0.676	3.44E-07
ENSG00000073756	PTGS2	0.676	4.47E-09
ENSG00000099974	DDTL	0.671	2.60E-02
ENSG00000258441	LINC00641	0.662	1.27E-07
ENSG00000186185	KIF18B	0.654	4.92E-12
ENSG00000280213	UCKL1-AS1	0.652	4.82E-02
ENSG00000099251	HSD17B7P2	0.651	1.17E-02
ENSG00000197847	SLC22A20	0.643	4.74E-03
ENSG00000115163	CENPA	0.642	2.25E-09
ENSG00000123610	TNFAIP6	0.636	4.22E-04
ENSG00000164400	CSF2	0.635	2.04E-02
ENSG00000136122	BORA	0.633	2.63E-09
ENSG00000184661	CDCA2	0.630	3.78E-12
ENSG00000112972	HMGCS1	0.619	8.58E-15
ENSG00000260083	MIR762HG	0.615	2.67E-02
ENSG00000052802	MSMO1	0.613	2.84E-12
ENSG00000196550	FAM72A	0.613	1.51E-05
ENSG00000087586	AURKA	0.611	2.03E-13
ENSG00000139318	DUSP6	0.611	2.71E-14
ENSG00000187951	ARHGAP11B	0.610	1.15E-10
ENSG00000127507	ADGRE2	0.609	4.31E-02
ENSG00000124171	PARD6B	0.593	3.95E-04
ENSG00000113161	HMGCR	0.591	3.04E-14
ENSG00000198331	HYLS1	0.585	4.35E-08
ENSG00000168386	FILIP1L	0.581	9.84E-07
ENSG00000182010	RTKN2	0.577	9.00E-03
ENSG00000169018	FEM1B	0.575	1.47E-11
ENSG00000075218	GTSE1	0.571	5.43E-10
ENSG00000157514	TSC22D3	0.569	7.65E-12
ENSG00000125657	TNFSF9	0.561	3.14E-02
ENSG00000242028	HYPK	0.552	2.69E-02
ENSG00000134690	CDCA8	0.549	1.22E-10
ENSG00000215784	FAM72D	0.547	1.00E-02
ENSG00000204390	HSPA1L	0.538	4.05E-02
ENSG00000100060	MFNG	0.535	1.73E-03
ENSG00000167565	SERTAD3	0.528	5.40E-07
ENSG00000110723	EXPH5	0.524	8.46E-06
ENSG00000198774	RASSF9	0.518	1.12E-04
ENSG00000212724	KRTAP2-3	0.518	2.06E-02
ENSG00000135451	TROAP	0.517	1.94E-09
ENSG00000188610	FAM72B	0.517	2.32E-06
ENSG00000130164	LDLR	0.510	6.56E-12
ENSG00000179820	MYADM	0.510	2.25E-09

ENSG00000169607	CKAP2L	0.509	7.65E-12
ENSG00000112984	KIF20A	0.508	5.08E-12
ENSG00000148200	NR6A1	0.507	2.05E-02
ENSG00000136167	LCP1	0.502	3.38E-03
ENSG00000163535	SGOL2	0.496	8.65E-09
ENSG00000085465	OVGP1	0.496	4.64E-02
ENSG00000024526	DEPDC1	0.495	1.54E-09
ENSG00000128016	ZFP36	0.493	4.86E-11
ENSG00000154040	CABYR	0.490	1.89E-04
ENSG00000137807	KIF23	0.490	3.08E-12
ENSG00000229124	VIM-AS1	0.488	2.57E-02
ENSG00000144655	CSRNP1	0.488	1.43E-07
ENSG00000011021	CLCN6	0.487	6.53E-08
ENSG00000066279	ASPM	0.486	3.31E-11
ENSG00000173320	STOX2	0.482	2.43E-02
ENSG00000148773	MKI67	0.478	3.72E-13
ENSG00000105327	BBC3	0.474	4.52E-03
ENSG00000006634	DBF4	0.472	7.40E-09
ENSG00000173530	TNFRSF10D	0.468	2.19E-10
ENSG00000119138	KLF9	0.467	1.40E-08
ENSG00000185361	TNFAIP8L1	0.463	7.13E-04
ENSG00000233966	UBE2SP1	0.459	2.93E-02
ENSG00000271425	NBPF10	0.458	3.08E-02
ENSG00000204305	AGER	0.455	9.26E-03
ENSG00000166851	PLK1	0.447	4.96E-10
ENSG00000162702	ZNF281	0.447	2.15E-09
ENSG00000123473	STIL	0.447	1.16E-09
ENSG00000188206	HNRNPU-AS1	0.446	7.55E-05
ENSG00000204923	FBXO48	0.443	1.40E-02
ENSG00000153721	CNKSR3	0.442	5.68E-03
ENSG00000111276	CDKN1B	0.438	2.57E-07
ENSG00000112658	SRF	0.438	7.87E-08
ENSG00000116285	ERRFI1	0.437	1.59E-10
ENSG00000167508	MVD	0.434	4.84E-09
ENSG00000111860	CEP85L	0.433	9.75E-03
ENSG00000092140	G2E3	0.431	2.36E-06
ENSG00000162194	LBHD1	0.431	3.95E-02
ENSG00000237649	KIFC1	0.430	1.54E-10
ENSG00000136108	CKAP2	0.429	3.01E-10
ENSG00000138061	CYP1B1	0.429	3.56E-11
ENSG00000160888	IER2	0.427	6.20E-07
ENSG00000100344	PNPLA3	0.427	9.69E-03
ENSG00000163661	PTX3	0.427	4.13E-03

ENSG00000117228	GBP1	0.421	1.41E-06
ENSG00000149503	INCENP	0.421	3.10E-10
ENSG00000172059	KLF11	0.419	5.32E-06
ENSG00000120217	CD274	0.417	8.06E-04
ENSG00000149591	TAGLN	0.414	4.15E-06
ENSG00000137135	ARHGEF39	0.411	2.26E-04
ENSG00000149639	SOGA1	0.410	5.43E-10
ENSG00000224660	SH3BP5-AS1	0.409	8.01E-03
ENSG00000109674	NEIL3	0.406	1.11E-05
ENSG00000134107	BHLHE40	0.405	1.67E-08
ENSG00000152926	ZNF117	0.405	1.11E-02
ENSG00000143630	HCN3	0.404	1.80E-02
ENSG00000122644	ARL4A	0.403	3.66E-05
ENSG00000185436	IFNLR1	0.401	4.04E-04
ENSG00000134324	LPIN1	0.399	3.25E-09
ENSG00000171940	ZNF217	0.398	1.33E-10
ENSG00000182700	IGIP	0.394	1.41E-02
ENSG00000110921	MVK	0.389	1.34E-06
ENSG00000109929	SC5D	0.389	1.11E-07
ENSG00000143847	PPFIA4	0.388	2.46E-02
ENSG00000175105	ZNF654	0.388	3.09E-04
ENSG00000172840	PDP2	0.385	3.27E-06
ENSG00000196544	BORCS6	0.385	2.13E-02
ENSG00000119737	GPR75	0.384	2.19E-02
ENSG00000122483	CCDC18	0.384	8.19E-06
ENSG00000073712	FERMT2	0.382	5.99E-09
ENSG00000197978	GOLGA6L9	0.379	3.21E-02
ENSG00000111912	NCOA7	0.379	1.51E-06
ENSG00000117724	CENPF	0.378	7.48E-11
ENSG00000241839	PLEKHO2	0.374	2.16E-04
ENSG00000112742	TTK	0.374	2.59E-08
ENSG00000125898	FAM110A	0.374	5.67E-05
ENSG00000188766	SPRED3	0.372	6.56E-03
ENSG00000204618	RNF39	0.370	2.86E-02
ENSG00000181827	RFX7	0.369	2.92E-08
ENSG00000141232	TOB1	0.369	1.39E-06
ENSG00000213186	TRIM59	0.369	3.77E-04
ENSG00000081019	RSBN1	0.368	5.31E-05
ENSG00000137462	TLR2	0.368	3.21E-05
ENSG00000148339	SLC25A25	0.367	6.55E-04
ENSG00000105617	LENG1	0.366	3.02E-03
ENSG00000129566	TEP1	0.366	2.91E-06
ENSG00000166073	GPR176	0.364	2.35E-03

ENSG00000172123	SLFN12	0.363	3.99E-03
ENSG00000198826	ARHGAP11A	0.362	1.02E-08
ENSG00000129173	E2F8	0.361	6.56E-06
ENSG00000115963	RND3	0.360	3.02E-07
ENSG00000136492	BRIP1	0.358	5.38E-08
ENSG00000178075	GRAMD1C	0.355	2.39E-02
ENSG00000147050	KDM6A	0.354	3.41E-06
ENSG00000213347	MXD3	0.354	1.10E-02
ENSG00000153933	DGKE	0.354	3.82E-04
ENSG00000130695	CEP85	0.353	1.69E-07
ENSG00000117650	NEK2	0.349	2.58E-06
ENSG00000169679	BUB1	0.349	5.47E-09
ENSG00000112182	BACH2	0.348	1.92E-04
ENSG00000196110	ZNF699	0.348	4.55E-02
ENSG00000127452	FBXL12	0.348	2.30E-04
ENSG00000042317	SPATA7	0.348	3.47E-02
ENSG00000187678	SPRY4	0.347	2.32E-06
ENSG00000068028	RASSF1	0.346	1.11E-05
ENSG00000140743	CDR2	0.346	5.32E-06
ENSG00000164104	HMGB2	0.345	3.07E-08
ENSG00000159388	BTG2	0.343	3.96E-04
ENSG00000111665	CDCA3	0.343	2.70E-06
ENSG00000138376	BARD1	0.341	1.08E-03
ENSG00000131069	ACSS2	0.341	1.63E-07
ENSG00000182919	C11orf54	0.341	3.02E-02
ENSG00000035403	VCL	0.341	4.27E-10
ENSG00000135334	AKIRIN2	0.339	1.39E-06
ENSG00000171295	ZNF440	0.339	5.73E-03
ENSG00000256087	ZNF432	0.338	5.42E-03
ENSG00000137812	CASC5	0.337	2.95E-08
ENSG00000234444	ZNF736	0.336	2.79E-02
ENSG00000088854	C20orf194	0.335	2.24E-05
ENSG00000164211	STARD4	0.335	1.79E-05
ENSG00000008086	CDKL5	0.334	1.11E-04
ENSG00000162769	FLVCR1	0.334	1.09E-04
ENSG00000080986	NDC80	0.334	2.82E-06
ENSG00000159208	CIART	0.333	3.55E-02
ENSG00000150991	UBC	0.332	2.11E-07
ENSG00000112029	FBXO5	0.331	8.26E-07
ENSG00000109084	TMEM97	0.330	1.58E-07
ENSG00000125740	FOSB	0.330	1.22E-03
ENSG00000004777	ARHGAP33	0.328	1.12E-02
ENSG00000185813	PCYT2	0.326	9.57E-05

ENSG00000161800	RACGAP1	0.326	2.37E-08
ENSG00000088325	TPX2	0.326	1.59E-10
ENSG00000131747	TOP2A	0.325	1.39E-09
ENSG00000126787	DLGAP5	0.322	6.59E-07
ENSG00000169155	ZBTB43	0.321	7.21E-06
ENSG00000116273	PHF13	0.319	4.21E-06
ENSG00000142677	IL22RA1	0.319	1.06E-02
ENSG00000143367	TUFT1	0.318	7.21E-06
ENSG00000154370	TRIM11	0.317	4.62E-06
ENSG00000188315	C3orf62	0.315	4.46E-03
ENSG00000269858	EGLN2	0.315	4.64E-02
ENSG00000139278	GLIPR1	0.314	5.31E-05
ENSG00000152359	POC5	0.312	2.48E-04
ENSG00000142945	KIF2C	0.309	6.81E-08
ENSG00000080298	RFX3	0.306	3.04E-02
ENSG00000129355	CDKN2D	0.306	3.24E-02
ENSG00000081320	STK17B	0.305	4.36E-05
ENSG00000185262	UBALD2	0.304	3.42E-04
ENSG00000104081	BMF	0.304	3.80E-02
ENSG00000090889	KIF4A	0.304	1.13E-05
ENSG00000114423	CBLB	0.303	1.03E-03
ENSG00000187772	LIN28B	0.302	1.35E-02
ENSG00000146373	RNF217	0.302	8.21E-05
ENSG00000161692	DBF4B	0.300	1.63E-04
ENSG00000032219	ARID4A	0.300	7.65E-04
ENSG00000121957	GPSM2	0.300	2.65E-07
ENSG00000078403	MLLT10	0.299	1.48E-05
ENSG00000134057	CCNB1	0.297	1.45E-06
ENSG00000156970	BUB1B	0.296	3.44E-07
ENSG00000170852	KBTBD2	0.296	4.02E-06
ENSG00000085276	MECOM	0.295	1.24E-02
ENSG00000171467	ZNF318	0.295	9.93E-06
ENSG00000129195	FAM64A	0.290	5.09E-04
ENSG00000163660	CCNL1	0.289	4.41E-06
ENSG00000120334	CENPL	0.289	5.79E-05
ENSG00000059804	SLC2A3	0.285	2.32E-03
ENSG00000151474	FRMD4A	0.285	2.89E-03
ENSG00000137331	IER3	0.284	1.16E-06
ENSG00000198556	ZNF789	0.283	1.97E-02
ENSG00000269821	KCNQ1OT1	0.282	1.19E-02
ENSG00000197822	OCLN	0.282	1.02E-03
ENSG00000153487	ING1	0.282	1.41E-03
ENSG00000112983	BRD8	0.281	5.53E-07

ENSG00000104221	BRF2	0.281	2.63E-02
ENSG00000270629	NBPF14	0.281	1.70E-02
ENSG00000132680	KIAA0907	0.279	4.95E-05
ENSG00000132196	HSD17B7	0.279	3.27E-02
ENSG00000196632	WNK3	0.278	4.32E-02
ENSG00000127666	TICAM1	0.278	1.48E-03
ENSG00000171316	CHD7	0.275	4.14E-05
ENSG00000179388	EGR3	0.274	2.67E-02
ENSG00000072864	NDE1	0.273	3.49E-06
ENSG00000148926	ADM	0.273	1.14E-02
ENSG00000132950	ZMYM5	0.271	3.99E-03
ENSG00000185485	SDHAP1	0.271	2.11E-02
ENSG00000177051	FBXO46	0.271	1.02E-03
ENSG00000104447	TRPS1	0.271	2.05E-03
ENSG00000126368	NR1D1	0.270	3.28E-04
ENSG00000172086	KRCC1	0.270	7.54E-04
ENSG00000144802	NFKBIZ	0.269	4.12E-03
ENSG00000165244	ZNF367	0.269	2.63E-04
ENSG00000149212	SESN3	0.269	4.58E-04
ENSG00000138160	KIF11	0.269	7.22E-07
ENSG00000180667	YOD1	0.269	3.83E-05
ENSG00000180336	C17orf104	0.268	4.13E-03
ENSG00000112343	TRIM38	0.268	1.38E-03
ENSG00000013441	CLK1	0.267	7.95E-05
ENSG00000121104	FAM117A	0.267	2.96E-02
ENSG00000135476	ESPL1	0.267	1.00E-04
ENSG00000123975	CKS2	0.267	1.85E-05
ENSG00000163961	RNF168	0.266	7.46E-04
ENSG00000065970	FOXJ2	0.265	1.09E-05
ENSG00000143322	ABL2	0.265	2.55E-04
ENSG00000104936	DMPK	0.265	3.23E-03
ENSG00000140682	TGFB1I1	0.265	2.31E-03
ENSG00000157450	RNF111	0.264	1.78E-05
ENSG00000131473	ACLY	0.264	4.17E-08
ENSG00000085185	BCORL1	0.264	3.26E-03
ENSG00000164951	PDP1	0.264	2.94E-04
ENSG00000141738	GRB7	0.264	2.95E-03
ENSG00000204569	PPP1R10	0.264	2.13E-07
ENSG00000137075	RNF38	0.263	1.16E-03
ENSG00000121211	MND1	0.262	1.87E-02
ENSG00000165030	NFIL3	0.261	2.09E-04
ENSG00000079432	CIC	0.261	5.02E-05
ENSG00000146278	PNRC1	0.261	1.62E-04

ENSG00000120868	APAF1	0.260	2.53E-03
ENSG00000115548	KDM3A	0.260	3.48E-05
ENSG00000128944	KNSTRN	0.260	3.29E-05
ENSG00000183856	IQGAP3	0.259	1.78E-05
ENSG00000138182	KIF20B	0.259	4.21E-06
ENSG00000142961	MOB3C	0.259	2.43E-03
ENSG00000100526	CDKN3	0.258	2.98E-04
ENSG00000145014	TMEM44	0.258	5.00E-02
ENSG00000163848	ZNF148	0.257	1.30E-05
ENSG00000104218	CSPP1	0.257	4.72E-03
ENSG00000213390	ARHGAP19	0.256	6.43E-03
ENSG00000198727	MT-CYB	0.255	1.42E-06
ENSG00000135837	CEP350	0.254	2.08E-06
ENSG00000137269	LRRC1	0.254	1.26E-02
ENSG00000101493	ZNF516	0.254	5.07E-03
ENSG00000166004	CEP295	0.254	2.43E-04
ENSG00000005483	KMT2E	0.253	6.60E-06
ENSG00000127124	HIVEP3	0.253	1.76E-02
ENSG00000103852	TTC23	0.253	1.63E-02
ENSG00000129116	PALLD	0.252	2.40E-06
ENSG00000166024	R3HCC1L	0.252	1.92E-03
ENSG00000145241	CENPC	0.252	2.91E-02
ENSG00000163110	PDLIM5	0.252	5.16E-06
ENSG00000173209	AHSA2	0.250	7.38E-03
ENSG00000079435	LIPE	0.250	3.80E-02
ENSG00000105287	PRKD2	0.249	2.88E-04
ENSG00000121931	LRIF1	0.249	3.46E-04
ENSG00000197961	ZNF121	0.249	7.18E-04
ENSG00000196652	ZKSCAN5	0.248	3.50E-04
ENSG00000152457	DCLRE1C	0.248	6.37E-03
ENSG00000120616	EPC1	0.247	1.06E-03
ENSG00000165782	TMEM55B	0.247	4.32E-03
ENSG00000099725	PRKY	0.247	2.46E-02
ENSG00000118620	ZNF430	0.247	2.08E-02
ENSG00000198646	NCOA6	0.247	1.87E-06
ENSG00000068137	PLEKHH3	0.246	4.71E-03
ENSG00000115904	SOS1	0.246	7.38E-05
ENSG00000138771	SHROOM3	0.245	1.11E-05
ENSG00000013810	TACC3	0.245	3.53E-06
ENSG00000119906	SLF2	0.245	1.27E-04
ENSG00000170325	PRDM10	0.244	5.68E-03
ENSG00000067064	IDI1	0.244	9.08E-05
ENSG00000119965	C10orf88	0.244	4.04E-02

ENSG00000184384	MAML2	0.242	5.70E-03
ENSG00000122779	TRIM24	0.242	1.93E-04
ENSG00000159256	MORC3	0.242	6.97E-04
ENSG00000064666	CNN2	0.242	4.02E-06
ENSG00000089916	GPATCH2L	0.242	4.27E-05
ENSG00000118193	KIF14	0.241	7.26E-05
ENSG00000152217	SETBP1	0.241	7.74E-03
ENSG00000146112	PPP1R18	0.241	8.72E-07
ENSG00000178295	GEN1	0.241	4.64E-04
ENSG00000197056	ZMYM1	0.240	3.05E-02
ENSG00000118518	RNF146	0.240	8.43E-03
ENSG00000099849	RASSF7	0.240	1.62E-02
ENSG00000078699	CBFA2T2	0.239	3.87E-04
ENSG00000169174	PCSK9	0.239	1.03E-03
ENSG00000163659	TIPARP	0.239	5.27E-06
ENSG00000188786	MTF1	0.239	1.08E-04
ENSG00000077458	FAM76B	0.239	2.16E-03
ENSG00000104549	SQLE	0.238	1.27E-06
ENSG00000217128	FNIP1	0.238	4.04E-04
ENSG00000138180	CEP55	0.237	9.08E-06
ENSG00000100802	C14orf93	0.237	3.26E-02
ENSG00000101574	METTL4	0.236	2.23E-02
ENSG00000141664	ZCCHC2	0.235	2.10E-04
ENSG00000177125	ZBTB34	0.235	1.78E-02
ENSG00000169908	TM4SF1	0.235	1.30E-03
ENSG00000142731	PLK4	0.235	2.05E-05
ENSG00000158321	AUTS2	0.235	4.52E-03
ENSG00000169914	OTUD3	0.235	1.80E-02
ENSG00000240230	COX19	0.235	2.72E-03
ENSG00000167657	DAPK3	0.234	3.94E-04
ENSG00000117461	PIK3R3	0.234	3.78E-03
ENSG00000175063	UBE2C	0.234	4.57E-06
ENSG00000112210	RAB23	0.233	3.82E-03
ENSG00000072571	HMMR	0.232	2.12E-04
ENSG00000122257	RBBP6	0.232	2.89E-06
ENSG00000105325	FZR1	0.230	1.50E-03
ENSG00000075702	WDR62	0.230	2.27E-03
ENSG00000198799	LRIG2	0.229	3.33E-03
ENSG00000106346	USP42	0.229	4.98E-04
ENSG00000186871	ERCC6L	0.229	3.55E-03
ENSG00000113070	HBEGF	0.229	1.30E-03
ENSG00000112941	PAPD7	0.228	2.62E-05
ENSG00000179604	CDC42EP4	0.228	2.64E-04

ENSG00000168137	SETD5	0.228	9.26E-06
ENSG00000153975	ZUFSP	0.228	1.43E-02
ENSG00000100842	EFS	0.227	2.76E-02
ENSG00000011426	ANLN	0.227	7.43E-07
ENSG00000109920	FNBP4	0.226	1.97E-05
ENSG00000198786	MT-ND5	0.226	9.61E-05
ENSG00000052795	FNIP2	0.226	2.15E-02
ENSG00000145386	CCNA2	0.225	5.20E-05
ENSG00000185215	TNFAIP2	0.225	1.67E-02
ENSG00000102401	ARMCX3	0.225	4.39E-03
ENSG00000138166	DUSP5	0.225	6.11E-03
ENSG00000101255	TRIB3	0.224	2.86E-05
ENSG00000160685	ZBTB7B	0.224	1.87E-03
ENSG00000112624	GLTSCR1L	0.224	3.66E-02
ENSG00000049246	PER3	0.223	2.32E-03
ENSG00000088356	PDRG1	0.223	6.21E-03
ENSG00000184863	RBM33	0.223	3.29E-05
ENSG00000165322	ARHGAP12	0.222	2.58E-03
ENSG00000168769	TET2	0.222	2.90E-03
ENSG00000143815	LBR	0.222	5.78E-04
ENSG00000131711	MAP1B	0.220	6.87E-05
ENSG00000140948	ZCCHC14	0.220	2.35E-03
ENSG00000173575	CHD2	0.219	6.82E-06
ENSG00000090924	PLEKHG2	0.219	1.62E-04
ENSG00000135945	REV1	0.218	1.87E-03
ENSG00000076382	SPAG5	0.218	2.23E-04
ENSG00000198121	LPAR1	0.218	1.07E-02
ENSG00000173614	NMNAT1	0.217	2.65E-02
ENSG00000181315	ZNF322	0.217	1.42E-02
ENSG00000158402	CDC25C	0.217	5.84E-03
ENSG00000070495	JMJD6	0.217	4.25E-03
ENSG00000108590	MED31	0.216	4.28E-02
ENSG00000137804	NUSAP1	0.216	2.91E-06
ENSG00000135365	PHF21A	0.216	1.99E-03
ENSG00000196369	SRGAP2B	0.215	3.37E-02
ENSG00000168795	ZBTB5	0.215	3.70E-03
ENSG00000080200	CRYBG3	0.215	7.97E-03
ENSG00000188827	SLX4	0.214	8.97E-03
ENSG00000198901	PRC1	0.214	1.11E-05
ENSG00000100439	ABHD4	0.213	6.38E-03
ENSG00000080802	CNOT4	0.213	2.20E-04
ENSG00000109046	WSB1	0.213	1.43E-03
ENSG00000105085	MED26	0.213	3.82E-02

ENSG00000143622	RIT1	0.212	5.58E-03
ENSG00000177000	MTHFR	0.212	1.38E-02
ENSG00000151929	BAG3	0.212	7.24E-06
ENSG00000175216	CKAP5	0.212	2.97E-06
ENSG00000073711	PPP2R3A	0.212	2.16E-02
ENSG00000082269	FAM135A	0.212	5.49E-03
ENSG00000165209	STRBP	0.211	1.45E-02
ENSG00000161642	ZNF385A	0.211	3.50E-04
ENSG00000157796	WDR19	0.210	1.31E-02
ENSG00000130479	MAP1S	0.210	3.69E-03
ENSG00000183963	SMTN	0.210	7.79E-04
ENSG00000261221	ZNF865	0.210	3.66E-02
ENSG00000088808	PPP1R13B	0.210	3.95E-03
ENSG00000117226	GBP3	0.210	1.42E-02
ENSG00000118922	KLF12	0.210	1.51E-02
ENSG00000142875	PRKACB	0.209	3.10E-02
ENSG00000186073	C15orf41	0.209	3.42E-02
ENSG00000172893	DHCR7	0.209	8.86E-04
ENSG00000154429	CCSAP	0.209	3.94E-02
ENSG00000117000	RLF	0.209	2.74E-04
ENSG00000142867	BCL10	0.208	2.94E-03
ENSG00000108091	CCDC6	0.208	4.24E-04
ENSG00000156232	WHAMM	0.207	1.23E-02
ENSG00000132879	FBXO44	0.207	4.51E-02
ENSG00000113328	CCNG1	0.205	6.02E-04
ENSG00000157456	CCNB2	0.205	1.24E-04
ENSG00000212907	MT-ND4L	0.204	1.89E-03
ENSG00000172244	C5orf34	0.204	4.20E-02
ENSG00000148158	SNX30	0.203	2.15E-02
ENSG00000166801	FAM111A	0.203	2.21E-04
ENSG00000177200	CHD9	0.203	7.55E-05
ENSG00000165480	SKA3	0.202	4.04E-04
ENSG00000171241	SHCBP1	0.202	2.65E-03
ENSG00000178996	SNX18	0.201	6.52E-03
ENSG00000100906	NFKBIA	0.201	8.60E-05
ENSG00000070159	PTPN3	0.201	1.70E-04
ENSG00000176018	LYSMD3	0.201	1.10E-02
ENSG00000189079	ARID2	0.201	1.10E-03
ENSG00000168389	MFSD2A	0.201	3.49E-04
ENSG00000178074	C2orf69	0.200	3.41E-02
ENSG00000162139	NEU3	0.200	1.26E-02
ENSG00000113368	LMNB1	0.200	3.83E-05
ENSG00000035499	DEPDC1B	0.200	4.41E-03

ENSG00000117399	CDC20	0.200	6.57E-05
ENSG00000119397	CNTRL	0.200	5.88E-03
ENSG00000167460	TPM4	0.199	9.19E-07
ENSG00000134899	ERCC5	0.199	2.21E-02
ENSG00000177602	GSG2	0.199	6.98E-03
ENSG00000198886	MT-ND4	0.199	3.77E-04
ENSG00000147383	NSDHL	0.198	3.38E-03
ENSG00000117758	STX12	0.197	1.02E-02
ENSG00000169375	SIN3A	0.197	5.67E-05
ENSG00000052344	PRSS8	0.197	1.86E-02
ENSG00000107771	CCSER2	0.197	5.65E-03
ENSG00000105939	ZC3HAV1	0.196	1.91E-05
ENSG00000183137	CEP57L1	0.196	3.66E-02
ENSG00000102384	CENPI	0.195	1.55E-02
ENSG00000112701	SENP6	0.195	1.64E-03
ENSG00000133808	MICALCL	0.195	3.38E-02
ENSG00000173334	TRIB1	0.195	1.24E-02
ENSG00000156876	SASS6	0.194	2.92E-02
ENSG00000204516	MICB	0.194	4.00E-03
ENSG00000175104	TRAF6	0.194	2.65E-02
ENSG00000174106	LEMD3	0.194	1.92E-03
ENSG00000179833	SERTAD2	0.194	1.11E-03
ENSG00000130856	ZNF236	0.192	2.75E-02
ENSG00000113810	SMC4	0.192	2.13E-04
ENSG00000068745	IP6K2	0.192	9.45E-04
ENSG00000178951	ZBTB7A	0.192	1.17E-03
ENSG00000228794	LINC01128	0.192	4.44E-02
ENSG00000120063	GNA13	0.192	1.50E-03
ENSG00000204138	PHACTR4	0.192	5.16E-04
ENSG00000102096	PIM2	0.192	3.21E-02
ENSG00000176624	MEX3C	0.191	1.35E-03
ENSG00000165288	BRWD3	0.191	3.43E-03
ENSG00000122741	DCAF10	0.191	9.58E-03
ENSG00000120437	ACAT2	0.190	2.19E-04
ENSG00000176542	USF3	0.190	2.13E-02
ENSG00000157224	CLDN12	0.190	1.99E-02
ENSG00000105879	CBLL1	0.190	5.82E-04
ENSG00000184009	ACTG1	0.189	1.05E-05
ENSG00000100416	TRMU	0.189	1.18E-02
ENSG00000108389	MTMR4	0.189	3.70E-03
ENSG00000051825	MPHOSPH9	0.189	1.51E-02
ENSG00000132109	TRIM21	0.189	4.49E-02
ENSG00000156875	HIAT1	0.188	4.18E-04

ENSG00000254087	LYN	0.188	3.98E-03
ENSG00000169991	IFFO2	0.187	3.39E-04
ENSG00000162775	RBM15	0.187	2.56E-03
ENSG00000183735	TBK1	0.187	5.70E-03
ENSG00000169710	FASN	0.187	7.63E-04
ENSG00000118058	KMT2A	0.187	7.79E-04
ENSG00000177853	ZNF518A	0.186	1.46E-02
ENSG00000139746	RBM26	0.186	1.06E-03
ENSG00000272333	KMT2B	0.186	3.35E-03
ENSG00000107372	ZFAND5	0.186	2.88E-03
ENSG00000083307	GRHL2	0.186	1.44E-02
ENSG00000143514	TP53BP2	0.185	2.98E-03
ENSG00000131002	TXLNGY	0.185	3.60E-02
ENSG00000138764	CCNG2	0.185	7.99E-03
ENSG00000170734	POLH	0.185	1.42E-02
ENSG00000102780	DGKH	0.185	1.93E-03
ENSG00000162852	CNST	0.185	2.75E-02
ENSG00000196233	LCOR	0.184	2.56E-03
ENSG00000151612	ZNF827	0.184	3.08E-02
ENSG00000138688	KIAA1109	0.184	1.38E-03
ENSG00000157985	AGAP1	0.184	2.94E-03
ENSG00000172081	MOB3A	0.184	2.94E-03
ENSG00000116717	GADD45A	0.184	1.39E-03
ENSG00000135749	PCNXL2	0.183	1.88E-02
ENSG00000100154	TTC28	0.183	2.45E-02
ENSG00000147548	WHSC1L1	0.183	2.00E-04
ENSG00000141219	C17orf80	0.183	3.24E-02
ENSG00000152133	GPATCH11	0.182	1.93E-02
ENSG00000174718	KIAA1551	0.182	9.86E-03
ENSG00000121210	KIAA0922	0.182	2.56E-02
ENSG00000122966	CIT	0.182	3.97E-04
ENSG00000185697	MYBL1	0.182	3.12E-02
ENSG00000186638	KIF24	0.181	2.01E-02
ENSG00000089685	BIRC5	0.181	3.68E-04
ENSG00000130699	TAF4	0.181	2.09E-03
ENSG00000052126	PLEKHA5	0.180	2.42E-03
ENSG00000010292	NCAPD2	0.180	1.36E-04
ENSG00000110925	CSRNP2	0.180	2.90E-03
ENSG00000173889	PHC3	0.180	1.37E-03
ENSG00000077157	PPP1R12B	0.180	4.29E-02
ENSG00000063978	RNF4	0.179	2.86E-04
ENSG00000151553	FAM160B1	0.179	3.70E-02
ENSG00000143228	NUF2	0.179	1.32E-02

ENSG00000173273	TNKS	0.179	1.56E-03
ENSG00000172795	DCP2	0.179	2.25E-02
ENSG00000129534	MIS18BP1	0.179	1.16E-02
ENSG00000134982	APC	0.179	1.57E-04
ENSG00000070476	ZXDC	0.178	3.79E-02
ENSG00000159348	CYB5R1	0.178	3.69E-03
ENSG00000103657	HERC1	0.177	1.02E-02
ENSG00000114933	INO80D	0.176	8.08E-03
ENSG00000108256	NUFIP2	0.176	2.08E-04
ENSG00000119844	AFTPH	0.175	1.21E-02
ENSG00000163171	CDC42EP3	0.175	1.04E-03
ENSG00000183955	SETD8	0.175	6.08E-04
ENSG00000123124	WWP1	0.174	1.61E-02
ENSG00000136152	COG3	0.174	8.01E-03
ENSG00000171681	ATF7IP	0.174	9.45E-04
ENSG00000136715	SAP130	0.173	7.27E-03
ENSG00000168502	MTCL1	0.172	3.48E-02
ENSG00000278311	GGNBP2	0.172	4.94E-04
ENSG00000060749	QSER1	0.172	7.57E-04
ENSG00000142871	CYR61	0.172	8.05E-03
ENSG00000135317	SNX14	0.171	9.57E-03
ENSG00000184677	ZBTB40	0.171	9.97E-03
ENSG00000170540	ARL6IP1	0.170	8.54E-03
ENSG00000149231	CCDC82	0.170	3.32E-02
ENSG00000115977	AAK1	0.170	3.11E-03
ENSG00000075391	RASAL2	0.170	8.01E-03
ENSG00000181555	SETD2	0.169	1.94E-04
ENSG00000165671	NSD1	0.169	1.92E-04
ENSG00000118503	TNFAIP3	0.169	3.50E-04
ENSG00000117616	RSRP1	0.169	4.78E-02
ENSG00000188895	MSL1	0.169	5.31E-04
ENSG00000108106	UBE2S	0.168	7.17E-03
ENSG00000036549	ZZZ3	0.168	8.21E-04
ENSG00000272886	DCP1A	0.168	6.58E-03
ENSG00000137145	DENND4C	0.167	1.02E-02
ENSG00000039523	FAM65A	0.167	1.76E-02
ENSG00000196950	SLC39A10	0.167	2.15E-02
ENSG00000132002	DNAJB1	0.167	1.32E-03
ENSG00000123636	BAZ2B	0.167	3.95E-03
ENSG00000062725	APPBP2	0.166	3.20E-02
ENSG00000134744	ZCCHC11	0.166	5.66E-03
ENSG00000137413	TAF8	0.166	3.82E-02
ENSG00000110395	CBL	0.166	5.34E-04

ENSG00000100092	SH3BP1	0.165	5.15E-03
ENSG00000070018	LRP6	0.165	4.47E-03
ENSG00000172732	MUS81	0.165	2.15E-02
ENSG00000156463	SH3RF2	0.165	1.42E-03
ENSG00000144283	PKP4	0.165	5.78E-04
ENSG00000198586	TLK1	0.164	4.22E-03
ENSG00000178974	FBXO34	0.164	2.87E-02
ENSG00000182831	C16orf72	0.164	9.51E-03
ENSG00000114346	ECT2	0.164	5.11E-03
ENSG00000154760	SLFN13	0.164	2.34E-03
ENSG00000166037	CEP57	0.164	1.60E-02
ENSG00000120137	PANK3	0.164	2.94E-03
ENSG00000149657	LSM14B	0.164	3.57E-03
ENSG00000143442	POGZ	0.164	2.12E-03
ENSG00000165055	METTL2B	0.163	1.83E-02
ENSG00000105722	ERF	0.163	2.94E-03
ENSG00000107816	LZTS2	0.163	4.09E-02
ENSG00000167173	C15orf39	0.163	1.15E-02
ENSG00000116539	ASH1L	0.163	8.78E-04
ENSG00000168575	SLC20A2	0.163	9.97E-04
ENSG00000197555	SIPA1L1	0.163	4.29E-04
ENSG00000020256	ZFP64	0.162	3.75E-02
ENSG00000198824	CHAMP1	0.162	3.58E-03
ENSG00000167081	PBX3	0.161	4.00E-02
ENSG00000154237	LRRK1	0.160	2.50E-02
ENSG00000248527	MTATP6P1	0.160	3.20E-03
ENSG00000161791	FMNL3	0.160	4.11E-02
ENSG00000136451	VEZF1	0.160	4.33E-03
ENSG00000033800	PIAS1	0.160	6.17E-03
ENSG00000109805	NCAPG	0.159	3.87E-03
ENSG00000170085	SIMC1	0.158	2.87E-02
ENSG00000055609	KMT2C	0.158	2.26E-03
ENSG00000168522	FNTA	0.158	2.27E-02
ENSG00000121741	ZMYM2	0.158	2.87E-03
ENSG00000145715	RASA1	0.158	5.98E-03
ENSG00000178105	DDX10	0.158	1.62E-02
ENSG00000119328	FAM206A	0.157	3.24E-02
ENSG00000122482	ZNF644	0.157	7.76E-03
ENSG00000266028	SRGAP2	0.156	9.75E-03
ENSG00000198160	MIER1	0.156	1.88E-02
ENSG00000179335	CLK3	0.156	1.46E-02
ENSG00000109066	TMEM104	0.156	3.69E-02
ENSG00000163960	UBXN7	0.156	2.11E-03

ENSG00000167842	MIS12	0.156	3.99E-02
ENSG00000198853	RUSC2	0.155	2.08E-02
ENSG00000162783	IER5	0.155	1.55E-02
ENSG00000101745	ANKRD12	0.155	2.06E-02
ENSG00000050327	ARHGEF5	0.154	4.56E-02
ENSG00000103061	SLC7A6OS	0.154	4.62E-02
ENSG00000031003	FAM13B	0.154	1.71E-02
ENSG00000128881	TTBK2	0.154	2.13E-02
ENSG00000117139	KDM5B	0.154	2.09E-03
ENSG00000159840	ZYX	0.153	2.06E-03
ENSG00000117713	ARID1A	0.152	4.22E-03
ENSG00000101945	SUV39H1	0.152	4.13E-02
ENSG00000084112	SSH1	0.152	6.79E-04
ENSG00000125386	FAM193A	0.152	1.45E-02
ENSG00000140577	CRTC3	0.152	4.22E-02
ENSG00000101191	DIDO1	0.152	1.23E-03
ENSG00000111206	FOXM1	0.151	5.98E-04
ENSG00000116044	NFE2L2	0.151	9.19E-04
ENSG00000103404	USP31	0.151	1.84E-02
ENSG00000048649	RSF1	0.151	5.70E-03
ENSG00000160785	SLC25A44	0.151	7.45E-03
ENSG00000120733	KDM3B	0.151	1.50E-03
ENSG00000186260	MKL2	0.151	1.26E-02
ENSG00000163507	KIAA1524	0.151	4.70E-02
ENSG00000141298	SSH2	0.150	3.28E-02
ENSG00000153914	SREK1	0.150	4.33E-03
ENSG00000204842	ATXN2	0.150	7.80E-03
ENSG00000170234	PWWP2A	0.150	2.08E-02
ENSG00000151748	SAV1	0.150	3.01E-02
ENSG00000116580	GON4L	0.150	1.13E-02
ENSG00000166886	NAB2	0.150	1.50E-02
ENSG00000179912	R3HDM2	0.150	4.65E-02
ENSG00000116127	ALMS1	0.149	8.01E-03
ENSG00000112242	E2F3	0.149	1.65E-02
ENSG00000196628	TCF4	0.148	3.25E-02
ENSG00000154839	SKA1	0.148	1.42E-02
ENSG00000127191	TRAF2	0.148	3.06E-02
ENSG00000140382	HMG20A	0.148	4.49E-02
ENSG00000204389	HSPA1A	0.148	4.05E-02
ENSG00000047056	WDR37	0.148	4.12E-02
ENSG00000138802	SEC24B	0.147	2.15E-02
ENSG00000145779	TNFAIP8	0.147	3.82E-02
ENSG00000173456	RNF26	0.147	1.21E-02

ENSG00000119787	ATL2	0.147	2.51E-02
ENSG00000076108	BAZ2A	0.147	2.97E-04
ENSG00000109686	SH3D19	0.146	7.08E-03
ENSG00000125875	TBC1D20	0.145	5.73E-03
ENSG00000163510	CWC22	0.145	1.86E-02
ENSG00000188994	ZNF292	0.144	2.18E-02
ENSG00000177606	JUN	0.144	2.05E-02
ENSG00000113739	STC2	0.144	8.88E-04
ENSG00000189180	ZNF33A	0.144	3.42E-02
ENSG00000152193	RNF219	0.144	3.94E-02
ENSG00000213516	RBMXL1	0.144	4.91E-02
ENSG00000147162	OGT	0.143	2.18E-02
ENSG00000104756	KCTD9	0.143	4.96E-03
ENSG00000197321	SVIL	0.143	4.44E-03
ENSG00000163539	CLASP2	0.143	3.02E-02
ENSG00000109118	PHF12	0.142	1.17E-02
ENSG00000095787	WAC	0.142	5.28E-04
ENSG00000164190	NIPBL	0.141	7.33E-04
ENSG00000170776	AKAP13	0.141	8.08E-03
ENSG00000140464	PML	0.141	2.34E-02
ENSG00000121152	NCAPH	0.141	1.46E-02
ENSG00000125826	RBCK1	0.141	9.75E-03
ENSG00000106462	EZH2	0.140	9.45E-03
ENSG00000175455	CCDC14	0.140	4.18E-02
ENSG00000127870	RNF6	0.140	4.01E-03
ENSG00000169504	CLIC4	0.139	1.28E-02
ENSG00000110906	KCTD10	0.139	3.70E-03
ENSG00000139083	ETV6	0.139	2.30E-02
ENSG00000236287	ZBED5	0.139	3.23E-02
ENSG00000104133	SPG11	0.138	3.27E-02
ENSG00000158615	PPP1R15B	0.138	3.05E-03
ENSG00000185591	SP1	0.138	2.88E-03
ENSG00000133858	ZFC3H1	0.138	2.39E-02
ENSG00000198899	MT-ATP6	0.138	1.24E-02
ENSG00000198815	FOXJ3	0.138	6.64E-03
ENSG00000169641	LUZP1	0.137	2.58E-03
ENSG00000169118	CSNK1G1	0.137	3.40E-02
ENSG00000273559	CWC25	0.137	4.26E-02
ENSG00000082701	GSK3B	0.137	5.59E-03
ENSG00000153317	ASAP1	0.137	3.35E-03
ENSG00000182481	KPNA2	0.137	7.03E-04
ENSG00000197579	TOPORS	0.136	9.53E-03
ENSG00000156011	PSD3	0.136	2.94E-02

ENSG00000136811	ODF2	0.136	1.36E-02
ENSG00000123066	MED13L	0.136	1.14E-02
ENSG00000068305	MEF2A	0.136	3.96E-02
ENSG00000068489	PRR11	0.135	1.45E-02
ENSG00000122299	ZC3H7A	0.135	4.31E-02
ENSG00000101596	SMCHD1	0.135	2.96E-02
ENSG00000156860	FBRS	0.134	1.90E-02
ENSG00000062598	ELMO2	0.134	3.07E-02
ENSG00000133226	SRRM1	0.134	3.08E-03
ENSG00000113456	RAD1	0.134	4.26E-02
ENSG00000101773	RBBP8	0.134	2.42E-03
ENSG00000147471	PROSC	0.133	3.82E-02
ENSG00000120709	FAM53C	0.132	1.24E-02
ENSG00000120539	MASTL	0.132	2.87E-02
ENSG00000067369	TP53BP1	0.132	3.27E-02
ENSG00000101639	CEP192	0.132	3.52E-02
ENSG00000170037	CNTROB	0.131	3.41E-02
ENSG00000114120	SLC25A36	0.131	4.49E-02
ENSG00000038382	TRIO	0.131	1.57E-02
ENSG00000142599	RERE	0.131	1.34E-02
ENSG00000070961	ATP2B1	0.130	3.40E-02
ENSG00000197323	TRIM33	0.130	2.55E-02
ENSG00000128731	HERC2	0.130	3.20E-02
ENSG00000138246	DNAJC13	0.130	1.44E-02
ENSG00000126653	NSRP1	0.129	3.38E-02
ENSG00000100796	PPP4R3A	0.129	3.53E-03
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ENSG00000157106	SMG1	0.127	1.13E-02
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ENSG00000163029	SMC6	0.127	1.26E-02
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ENSG00000128283	CDC42EP1	0.127	4.18E-02
ENSG00000126883	NUP214	0.126	4.50E-03
ENSG00000088387	DOCK9	0.126	1.88E-02
ENSG00000133789	SWAP70	0.126	3.08E-02
ENSG00000123200	ZC3H13	0.126	5.73E-03
ENSG00000080845	DLGAP4	0.126	1.80E-02
ENSG00000172466	ZNF24	0.125	2.08E-02
ENSG00000104413	ESRP1	0.125	1.10E-02
ENSG00000129680	MAP7D3	0.125	4.83E-02
ENSG00000136709	WDR33	0.125	5.54E-03

ENSG00000143614	GATAD2B	0.124	4.45E-02
ENSG00000067082	KLF6	0.124	9.61E-03
ENSG00000075711	DLG1	0.124	3.02E-02
ENSG00000004897	CDC27	0.124	4.30E-03
ENSG00000161638	ITGA5	0.124	1.86E-02
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ENSG00000168488	ATXN2L	0.123	2.46E-02
ENSG00000198888	MT-ND1	0.123	3.29E-02
ENSG00000139990	DCAF5	0.123	1.34E-02
ENSG00000137337	MDC1	0.123	1.02E-02
ENSG00000175215	CTDSP2	0.123	1.40E-02
ENSG00000134644	PUM1	0.122	9.26E-03
ENSG00000136802	LRRC8A	0.122	1.35E-02
ENSG00000084652	TXLNA	0.121	1.26E-02
ENSG00000115008	IL1A	0.121	3.28E-02
ENSG00000115464	USP34	0.121	1.24E-02
ENSG00000117360	PRPF3	0.121	4.27E-02
ENSG00000120802	TMPO	0.120	1.98E-02
ENSG00000019995	ZRANB1	0.120	3.95E-02
ENSG00000128245	YWHAH	0.119	1.21E-02
ENSG00000156304	SCAF4	0.119	2.44E-02
ENSG00000143776	CDC42BPA	0.118	3.99E-02
ENSG00000104517	UBR5	0.118	7.20E-03
ENSG00000153922	CHD1	0.118	8.67E-03
ENSG00000112159	MDN1	0.118	1.41E-02
ENSG00000170873	MTSS1	0.118	3.23E-02
ENSG00000170921	TANC2	0.118	1.38E-02
ENSG00000181467	RAP2B	0.117	4.01E-02
ENSG00000100393	EP300	0.117	3.51E-02
ENSG00000003402	CFLAR	0.117	2.45E-02
ENSG00000197183	NOL4L	0.116	4.94E-02
ENSG00000075292	ZNF638	0.116	2.45E-02
ENSG00000168883	USP39	0.116	3.46E-02
ENSG00000051620	HEBP2	0.116	3.91E-02
ENSG00000163374	YY1AP1	0.115	3.28E-02
ENSG00000198840	MT-ND3	0.115	1.66E-03
ENSG00000049618	ARID1B	0.115	4.16E-02
ENSG00000145675	PIK3R1	0.114	1.47E-02
ENSG00000113360	DROSHA	0.114	8.19E-03
ENSG00000172493	AFF1	0.113	3.45E-02
ENSG00000160752	FDPS	0.113	3.29E-02
ENSG00000181222	POLR2A	0.113	3.36E-02
ENSG00000171456	ASXL1	0.112	8.82E-03

ENSG00000118900	UBN1	0.112	2.19E-02
ENSG00000115760	BIRC6	0.112	2.18E-02
ENSG00000011114	BTBD7	0.109	4.44E-02
ENSG00000068796	KIF2A	0.108	3.27E-02
ENSG00000055208	TAB2	0.108	2.08E-02
ENSG00000163946	FAM208A	0.107	2.64E-02
ENSG00000170242	USP47	0.106	5.00E-02
ENSG00000198763	MT-ND2	0.106	1.54E-02
ENSG00000071127	WDR1	0.106	1.45E-02
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ENSG00000093000	NUP50	0.105	2.84E-02
ENSG00000151914	DST	0.103	7.55E-03
ENSG00000100201	DDX17	0.103	3.31E-02
ENSG00000124151	NCOA3	0.101	1.62E-02
ENSG00000117523	PRRC2C	0.101	1.04E-02
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ENSG00000146670	CDCA5	0.097	3.87E-02
ENSG00000116584	ARHGEF2	0.097	4.00E-02
ENSG00000171634	BPTF	0.097	2.49E-02
ENSG00000122786	CALD1	0.095	3.57E-02
ENSG00000099194	SCD	0.094	1.02E-02
ENSG00000047410	TPR	0.093	3.13E-02
ENSG00000075624	ACTB	0.092	2.16E-02
ENSG00000110048	OSBP	0.089	4.49E-02
ENSG00000134762	DSC3	0.088	4.82E-02
ENSG00000167522	ANKRD11	0.088	3.08E-02
ENSG00000110713	NUP98	0.087	4.31E-02
ENSG00000125107	CNOT1	0.080	4.60E-02
ENSG00000108424	KPNB1	0.080	2.92E-02
ENSG00000186081	KRT5	-0.072	3.23E-02
ENSG00000100316	RPL3	-0.074	5.04E-02
ENSG00000174444	RPL4	-0.075	3.69E-02
ENSG00000168028	RPSA	-0.079	4.48E-02
ENSG00000125691	RPL23	-0.079	4.54E-02
ENSG00000148175	STOM	-0.080	5.01E-02
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ENSG00000174748	RPL15	-0.084	4.88E-02
ENSG00000140988	RPS2	-0.086	3.45E-02
ENSG00000113719	ERGIC1	-0.086	3.96E-02
ENSG00000196262	PPIA	-0.087	3.29E-02

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ENSG00000089280	FUS	-0.090	1.99E-02
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ENSG00000115053	NCL	-0.090	1.51E-02
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ENSG00000183696	UPP1	-0.091	4.55E-02
ENSG00000108298	RPL19	-0.092	4.06E-02
ENSG00000106628	POLD2	-0.092	3.87E-02
ENSG00000147955	SIGMAR1	-0.092	4.57E-02
ENSG00000147403	RPL10	-0.093	3.29E-02
ENSG00000143420	ENSA	-0.093	4.93E-02
ENSG00000136942	RPL35	-0.094	3.96E-02
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ENSG00000100029	PES1	-0.094	4.32E-02
ENSG00000132475	H3F3B	-0.095	1.70E-02
ENSG00000056097	ZFR	-0.095	4.00E-02
ENSG00000003056	M6PR	-0.096	4.38E-02
ENSG00000170027	YWHAG	-0.096	2.73E-02
ENSG00000189334	S100A14	-0.096	1.71E-02
ENSG00000187514	PTMA	-0.097	1.74E-02
ENSG00000105976	MET	-0.097	1.77E-02
ENSG00000073282	TP63	-0.098	3.38E-02
ENSG00000135480	KRT7	-0.098	4.54E-02
ENSG00000108561	C1QBP	-0.099	2.48E-02
ENSG00000069849	ATP1B3	-0.100	4.27E-02
ENSG00000162244	RPL29	-0.100	2.52E-02
ENSG00000069020	MAST4	-0.101	2.89E-02
ENSG00000029993	HMGB3	-0.102	3.18E-02
ENSG00000197622	CDC42SE1	-0.104	1.67E-02
ENSG00000165271	NOL6	-0.104	4.26E-02
ENSG00000137699	TRIM29	-0.105	4.22E-02
ENSG00000100644	HIF1A	-0.106	1.01E-02
ENSG00000104635	SLC39A14	-0.106	2.53E-02
ENSG00000174705	SH3PXD2B	-0.108	2.41E-02
ENSG00000097021	ACOT7	-0.108	3.25E-02
ENSG00000136930	PSMB7	-0.108	2.15E-02
ENSG00000055483	USP36	-0.109	2.57E-02
ENSG00000124107	SLPI	-0.109	2.02E-02
ENSG00000144713	RPL32	-0.109	1.02E-02

ENSG00000154723	ATP5J	-0.109	3.16E-02
ENSG00000010256	UQCRC1	-0.110	3.66E-02
ENSG00000064601	CTSA	-0.110	2.18E-02
ENSG00000099204	ABLIM1	-0.110	2.29E-02
ENSG00000136875	PRPF4	-0.111	2.47E-02
ENSG00000145592	RPL37	-0.111	3.98E-03
ENSG00000132824	SERINC3	-0.111	2.46E-02
ENSG00000084207	GSTP1	-0.111	1.66E-02
ENSG00000064932	SBNO2	-0.111	3.69E-02
ENSG00000143545	RAB13	-0.111	3.46E-02
ENSG00000166250	CLMP	-0.112	1.04E-02
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ENSG00000071553	ATP6AP1	-0.113	4.96E-02
ENSG00000048162	NOP16	-0.113	4.39E-02
ENSG00000176903	PNMA1	-0.114	4.41E-02
ENSG00000109971	HSPA8	-0.114	1.99E-03
ENSG00000196743	GM2A	-0.114	1.62E-02
ENSG00000133030	MPRIP	-0.114	1.17E-02
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ENSG00000083845	RPS5	-0.116	3.96E-02
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ENSG00000145247	OCIAD2	-0.124	1.97E-02
ENSG00000136827	TOR1A	-0.124	4.62E-02
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ENSG00000076706	MCAM	-0.124	3.69E-03
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ENSG00000152661	GJA1	-0.126	1.85E-02
ENSG00000111424	VDR	-0.126	4.39E-03
ENSG00000126822	PLEKHG3	-0.127	7.75E-03
ENSG00000164543	STK17A	-0.127	1.17E-02
ENSG00000162706	CADM3	-0.127	1.65E-02
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ENSG00000272398	CD24	-0.127	8.18E-03
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ENSG00000182107	TMEM30B	-0.134	3.69E-02
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ENSG00000154127	UBASH3B	-0.136	4.58E-02
ENSG00000204387	C6orf48	-0.136	1.69E-02

ENSG00000100836	PABPN1	-0.136	2.58E-02
ENSG00000273841	TAF9	-0.137	2.30E-02
ENSG00000149289	ZC3H12C	-0.137	3.29E-02
ENSG00000138386	NAB1	-0.137	4.42E-02
ENSG00000211445	GPX3	-0.137	1.19E-03
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ENSG00000070614	NDST1	-0.137	9.57E-03
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ENSG00000107404	DVL1	-0.139	2.02E-02
ENSG00000175416	CLTB	-0.139	1.62E-02
ENSG00000164687	FABP5	-0.140	3.89E-02
ENSG00000173113	TRMT112	-0.140	9.46E-03
ENSG00000118971	CCND2	-0.140	2.34E-02
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ENSG00000100285	NEFH	-0.140	9.46E-03
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ENSG00000168936	TMEM129	-0.141	4.24E-02
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ENSG00000120889	TNFRSF10B	-0.141	2.50E-03
ENSG00000108528	SLC25A11	-0.142	3.02E-02
ENSG00000233276	GPX1	-0.143	2.27E-02
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ENSG00000102312	PORCN	-0.143	1.28E-02
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ENSG00000134248	LAMTOR5	-0.146	4.18E-02
ENSG00000165283	STOML2	-0.146	1.77E-02
ENSG00000175866	BAIAP2	-0.147	4.64E-02
ENSG00000124120	TTPAL	-0.147	6.32E-03
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ENSG00000143486	EIF2D	-0.150	6.70E-03
ENSG00000102554	KLF5	-0.150	8.70E-04
ENSG00000006327	TNFRSF12A	-0.150	4.83E-03
ENSG00000109861	CTSC	-0.150	9.20E-04
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ENSG00000164465	DCBLD1	-0.154	6.35E-03
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ENSG00000188807	TMEM201	-0.155	2.92E-02
ENSG00000147164	SNX12	-0.155	1.13E-02
ENSG00000110218	PANX1	-0.156	1.65E-02
ENSG00000157557	ETS2	-0.156	3.48E-03
ENSG00000161091	MFSD12	-0.156	2.39E-02
ENSG00000168003	SLC3A2	-0.157	2.45E-03
ENSG00000198042	MAK16	-0.158	2.05E-02
ENSG00000107104	KANK1	-0.158	1.93E-03
ENSG00000171517	LPAR3	-0.158	4.14E-03
ENSG00000172590	MRPL52	-0.160	2.69E-02
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ENSG00000140548	ZNF710	-0.161	3.05E-02
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ENSG00000027697	IFNGR1	-0.168	7.69E-03
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ENSG00000165474	GJB2	-0.169	3.78E-03
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ENSG00000010818	HIVEP2	-0.172	1.95E-04
ENSG00000175352	NRIP3	-0.173	3.46E-02
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ENSG00000223496	EXOSC6	-0.174	1.02E-02
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ENSG00000166532	RIMKLB	-0.175	5.57E-03
ENSG00000175793	SFN	-0.175	1.06E-04
ENSG00000173846	PLK3	-0.175	2.63E-02
ENSG00000127334	DYRK2	-0.177	1.49E-02
ENSG00000005448	WDR54	-0.178	4.83E-02
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ENSG00000239900	ADSL	-0.178	1.38E-02
ENSG00000175591	P2RY2	-0.178	2.61E-02
ENSG00000006118	TMEM132A	-0.179	4.22E-03
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ENSG00000183309	ZNF623	-0.180	2.23E-02
ENSG00000159403	C1R	-0.180	2.78E-02
ENSG00000100138	SNU13	-0.181	7.83E-04
ENSG00000091409	ITGA6	-0.181	1.72E-05
ENSG00000140859	KIFC3	-0.182	3.42E-02
ENSG00000197037	ZSCAN25	-0.183	3.49E-02
ENSG00000125772	GPCPD1	-0.184	2.42E-03
ENSG00000187866	FAM122A	-0.184	4.23E-02

ENSG00000124217	MOCS3	-0.185	2.21E-02
ENSG00000150457	LATS2	-0.185	2.29E-02
ENSG00000021355	SERPINB1	-0.185	4.06E-02
ENSG00000184436	THAP7	-0.186	2.41E-02
ENSG00000198355	PIM3	-0.186	1.25E-02
ENSG00000120942	UBIAD1	-0.186	6.78E-03
ENSG00000162493	PDPN	-0.187	3.19E-03
ENSG00000132669	RIN2	-0.187	1.49E-03
ENSG00000125731	SH2D3A	-0.187	2.96E-03
ENSG00000136720	HS6ST1	-0.188	1.85E-02
ENSG00000167767	KRT80	-0.189	5.61E-03
ENSG00000171992	SYNPO	-0.190	8.59E-04
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ENSG00000115594	IL1R1	-0.190	2.08E-02
ENSG00000167716	WDR81	-0.191	1.42E-02
ENSG00000167601	AXL	-0.192	5.98E-04
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ENSG00000182795	C1orf116	-0.194	1.22E-05
ENSG00000180530	NRIP1	-0.194	7.65E-04
ENSG00000196372	ASB13	-0.195	1.67E-02
ENSG00000113742	CPEB4	-0.195	6.78E-03
ENSG00000156453	PCDH1	-0.195	1.57E-03
ENSG00000184990	SIVA1	-0.196	1.43E-02
ENSG00000140332	TLE3	-0.197	3.03E-03
ENSG00000105835	NAMPT	-0.197	4.04E-04
ENSG00000176170	SPHK1	-0.197	2.85E-03
ENSG00000213412	HNRNPA1P33	-0.197	8.08E-03
ENSG00000136490	LIMD2	-0.197	2.73E-02
ENSG00000143153	ATP1B1	-0.199	2.74E-04
ENSG00000264230	ANXA8L1	-0.199	1.57E-04
ENSG00000119922	IFIT2	-0.200	6.64E-03
ENSG00000114315	HES1	-0.200	2.72E-02
ENSG00000064545	TMEM161A	-0.201	3.12E-02
ENSG00000166741	NNMT	-0.201	6.07E-03
ENSG00000143479	DYRK3	-0.201	8.83E-03
ENSG00000122783	C7orf49	-0.201	1.92E-03
ENSG00000125089	SH3TC1	-0.201	1.25E-03
ENSG00000113645	WWC1	-0.202	1.59E-04
ENSG00000162757	C1orf74	-0.202	1.04E-02
ENSG00000023330	ALAS1	-0.203	9.83E-04
ENSG00000185219	ZNF445	-0.203	1.80E-02
ENSG00000027869	SH2D2A	-0.203	1.54E-02
ENSG00000088726	TMEM40	-0.204	1.48E-02

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ENSG00000075426	FOSL2	-0.205	5.47E-06
ENSG00000206075	SERPINB5	-0.208	2.81E-05
ENSG00000103257	SLC7A5	-0.210	4.93E-06
ENSG00000204946	ZNF783	-0.210	4.17E-03
ENSG00000173621	LRFN4	-0.211	1.76E-03
ENSG00000104368	PLAT	-0.212	4.47E-02
ENSG00000115884	SDC1	-0.212	3.21E-06
ENSG00000175906	ARL4D	-0.213	2.77E-03
ENSG00000184792	OSBP2	-0.213	1.33E-03
ENSG00000165272	AQP3	-0.213	1.99E-02
ENSG00000100558	PLEK2	-0.213	4.79E-04
ENSG00000150630	VEGFC	-0.215	1.11E-02
ENSG00000179862	CITED4	-0.215	4.51E-02
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ENSG00000112773	FAM46A	-0.216	4.18E-02
ENSG00000131845	ZNF304	-0.216	4.31E-02
ENSG00000141552	ANAPC11	-0.216	2.27E-02
ENSG00000111335	OAS2	-0.216	2.35E-02
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ENSG00000108179	PPIF	-0.217	1.02E-05
ENSG00000132510	KDM6B	-0.218	1.23E-03
ENSG00000189410	SH2D5	-0.219	4.80E-03
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ENSG00000114767	RRP9	-0.220	1.91E-03
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ENSG00000176476	SGF29	-0.222	3.08E-02
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ENSG00000147789	ZNF7	-0.223	2.32E-03
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ENSG00000115756	HPCAL1	-0.224	4.34E-03
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ENSG00000170549	IRX1	-0.225	4.28E-02
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ENSG00000101361	NOP56	-0.227	1.58E-06

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ENSG00000128591	FLNC	-0.229	4.02E-03
ENSG00000188636	LDOC1L	-0.229	4.55E-04
ENSG00000139289	PHLDA1	-0.229	5.42E-06
ENSG00000166189	HPS6	-0.229	4.22E-03
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ENSG00000133816	MICAL2	-0.230	2.25E-06
ENSG00000106799	TGFBR1	-0.230	5.90E-04
ENSG00000163738	MTHFD2L	-0.232	3.41E-02
ENSG00000121671	CRY2	-0.233	1.75E-02
ENSG00000135114	OASL	-0.233	1.60E-03
ENSG00000170345	FOS	-0.235	3.13E-05
ENSG00000173221	GLRX	-0.236	1.17E-02
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ENSG00000184731	FAM110C	-0.242	1.71E-03
ENSG00000152413	HOMER1	-0.243	1.47E-03
ENSG00000107262	BAG1	-0.244	1.12E-04
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ENSG00000157240	FZD1	-0.244	4.83E-02
ENSG00000179163	FUCA1	-0.248	5.88E-03
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ENSG00000184922	FMNL1	-0.261	2.17E-02
ENSG00000187608	ISG15	-0.261	1.42E-02
ENSG00000162650	ATXN7L2	-0.261	1.40E-02
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ENSG00000115507	OTX1	-0.269	1.03E-02
ENSG00000090447	TFAP4	-0.269	2.90E-03
ENSG00000180233	ZNRF2	-0.270	1.40E-02
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ENSG00000125459	MSTO1	-0.273	8.01E-03
ENSG00000043039	BARX2	-0.273	3.64E-02
ENSG00000049759	NEDD4L	-0.274	5.40E-07
ENSG00000158470	B4GALT5	-0.274	7.78E-07
ENSG00000136379	ABHD17C	-0.274	1.56E-03
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ENSG00000158747	NBL1	-0.276	4.49E-02
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ENSG00000231607	DLEU2	-0.280	3.65E-02
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ENSG00000122861	PLAU	-0.283	2.56E-06
ENSG00000139211	AMIGO2	-0.283	1.08E-04
ENSG00000136689	IL1RN	-0.283	1.54E-04
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ENSG00000183876	ARSI	-0.291	1.24E-03
ENSG00000163362	C1orf106	-0.291	2.16E-04
ENSG00000169684	CHRNA5	-0.291	1.26E-02
ENSG00000184903	IMMP2L	-0.293	2.46E-02
ENSG00000179094	PER1	-0.294	2.81E-06
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ENSG00000256235	SMIM3	-0.296	9.46E-03
ENSG00000196371	FUT4	-0.297	6.24E-03
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ENSG00000151617	EDNRA	-0.299	1.09E-02
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ENSG00000198018	ENTPD7	-0.302	6.21E-05
ENSG00000163702	IL17RC	-0.302	6.00E-03
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ENSG00000130449	ZSWIM6	-0.306	2.08E-06
ENSG00000178896	EXOSC4	-0.306	6.31E-04
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ENSG00000278709	NKILA	-0.310	2.80E-02
ENSG00000164251	F2RL1	-0.312	1.74E-05
ENSG00000153395	LPCAT1	-0.312	1.07E-07
ENSG00000145860	RNF145	-0.313	4.22E-07
ENSG00000110047	EHD1	-0.313	3.38E-07
ENSG00000129514	FOXA1	-0.314	3.17E-03
ENSG00000177508	IRX3	-0.315	1.38E-03
ENSG00000159216	RUNX1	-0.317	5.11E-07
ENSG00000112245	PTP4A1	-0.317	3.79E-07
ENSG00000122863	CHST3	-0.318	1.80E-08
ENSG00000145777	TSLP	-0.318	4.54E-02
ENSG00000169515	CCDC8	-0.319	3.06E-03
ENSG00000125775	SDCBP2	-0.321	2.02E-03
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ENSG00000176597	B3GNT5	-0.328	3.40E-07
ENSG00000186106	ANKRD46	-0.328	4.91E-02
ENSG00000185033	SEMA4B	-0.330	4.35E-08
ENSG00000168906	MAT2A	-0.330	9.64E-09
ENSG00000101311	FERMT1	-0.331	1.10E-08
ENSG00000100647	SUSD6	-0.332	3.05E-07
ENSG00000165572	KBTBD6	-0.332	5.02E-05
ENSG00000198841	KTI12	-0.336	2.44E-03
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ENSG00000184564	SLITRK6	-0.339	1.05E-03
ENSG00000185164	NOMO2	-0.339	3.16E-02
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ENSG00000265972	TXNIP	-0.342	1.07E-06
ENSG00000171617	ENC1	-0.342	2.28E-05
ENSG00000148344	PTGES	-0.346	1.39E-05
ENSG00000133121	STARD13	-0.347	7.71E-05
ENSG00000003989	SLC7A2	-0.348	9.52E-07
ENSG00000197375	SLC22A5	-0.348	5.54E-06
ENSG00000176595	KBTBD11	-0.350	3.02E-03
ENSG00000163235	TGFA	-0.351	2.44E-09
ENSG00000139725	RHOF	-0.351	1.51E-06
ENSG00000158050	DUSP2	-0.352	4.88E-02
ENSG00000137801	THBS1	-0.353	4.99E-09
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ENSG00000186603	HPDL	-0.356	5.78E-04
ENSG00000124145	SDC4	-0.358	4.83E-10
ENSG00000148154	UGCG	-0.359	1.06E-04
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ENSG00000249471	ZNF324B	-0.360	2.80E-02
ENSG00000171056	SOX7	-0.360	2.36E-06
ENSG00000174276	ZNHIT2	-0.362	1.91E-02
ENSG00000163207	IVL	-0.362	4.93E-02
ENSG00000115919	KYNU	-0.363	4.43E-03
ENSG00000109819	PPARGC1A	-0.364	1.03E-02
ENSG00000238266	LINC00707	-0.365	2.32E-05
ENSG00000163734	CXCL3	-0.366	2.52E-05
ENSG00000215012	C22orf29	-0.369	4.23E-06
ENSG00000127418	FGFRL1	-0.372	2.42E-08
ENSG00000133639	BTG1	-0.374	1.60E-06
ENSG00000175505	CLCF1	-0.375	4.41E-04
ENSG00000057704	TMCC3	-0.376	6.13E-07
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ENSG00000171488	LRRC8C	-0.382	2.32E-06
ENSG00000112033	PPARD	-0.383	6.97E-08
ENSG00000275183	LENG9	-0.386	5.40E-03
ENSG00000131019	ULBP3	-0.387	2.88E-02
ENSG00000198142	SOWAHC	-0.388	5.34E-09
ENSG00000170684	ZNF296	-0.390	1.47E-03
ENSG00000157551	KCNJ15	-0.391	2.58E-07
ENSG00000100036	SLC35E4	-0.392	1.47E-03
ENSG00000126778	SIX1	-0.394	2.89E-05
ENSG00000156113	KCNMA1	-0.395	2.46E-03
ENSG00000251493	FOXD1	-0.396	5.61E-03
ENSG00000154764	WNT7A	-0.401	3.74E-03
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ENSG00000134954	ETS1	-0.403	8.64E-11
ENSG00000124882	EREG	-0.405	1.17E-07
ENSG00000131016	AKAP12	-0.406	6.81E-08
ENSG00000131746	TNS4	-0.409	3.18E-11
ENSG00000168264	IRF2BP2	-0.410	7.48E-11
ENSG00000198618	PPIAP22	-0.417	3.84E-02
ENSG00000137393	RNF144B	-0.418	8.46E-06
ENSG00000189120	SP6	-0.418	5.14E-03
ENSG00000160712	IL6R	-0.419	6.36E-09
ENSG00000112149	CD83	-0.421	1.26E-04
ENSG00000169594	BNC1	-0.424	2.42E-11
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ENSG00000253313	C1orf210	-0.430	4.10E-02
ENSG00000164171	ITGA2	-0.432	4.65E-10
ENSG00000168685	IL7R	-0.434	1.37E-03
ENSG00000110987	BCL7A	-0.435	2.16E-07
ENSG00000177311	ZBTB38	-0.439	1.04E-11
ENSG00000101384	JAG1	-0.443	8.96E-11
ENSG00000054598	FOXC1	-0.443	4.57E-06
ENSG00000137094	DNAJB5	-0.445	2.83E-10
ENSG00000179846	NKPD1	-0.445	3.93E-02
ENSG00000182585	EPGN	-0.446	3.96E-04
ENSG00000185186	LINC00313	-0.447	2.23E-02
ENSG00000090776	EFNB1	-0.447	2.02E-10
ENSG00000177494	ZBED2	-0.454	2.63E-09
ENSG00000034152	MAP2K3	-0.462	1.37E-09
ENSG00000240891	PLCXD2	-0.463	4.71E-02

ENSG00000178919	FOXE1	-0.464	6.81E-03
ENSG00000109193	SULT1E1	-0.464	1.26E-02
ENSG00000122641	INHBA	-0.465	5.80E-08
ENSG00000081041	CXCL2	-0.466	1.37E-07
ENSG00000020633	RUNX3	-0.467	2.30E-03
ENSG00000137154	RPS6	-0.467	1.93E-05
ENSG00000184185	KCNJ12	-0.475	5.13E-04
ENSG00000088826	SMOX	-0.476	3.56E-08
ENSG00000137218	FRS3	-0.483	3.19E-03
ENSG00000128342	LIF	-0.485	3.53E-10
ENSG00000196878	LAMB3	-0.485	4.92E-12
ENSG00000180758	GPR157	-0.486	1.52E-05
ENSG00000108342	CSF3	-0.488	8.19E-08
ENSG00000111218	PRMT8	-0.489	3.42E-02
ENSG00000196352	CD55	-0.499	2.37E-11
ENSG00000124766	SOX4	-0.502	2.79E-10
ENSG00000114251	WNT5A	-0.504	5.98E-03
ENSG00000118515	SGK1	-0.508	1.25E-08
ENSG00000188483	IER5L	-0.511	3.76E-06
ENSG00000124225	PMEPA1	-0.514	1.37E-09
ENSG00000162894	FCMR	-0.515	4.96E-03
ENSG00000172216	CEBPB	-0.517	1.08E-09
ENSG00000254703	SENCR	-0.517	3.70E-03
ENSG00000176692	FOXC2	-0.521	4.59E-09
ENSG00000012171	SEMA3B	-0.528	2.12E-06
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ENSG00000125538	IL1B	-0.532	3.70E-11
ENSG00000143867	OSR1	-0.535	1.07E-02
ENSG00000115758	ODC1	-0.542	6.29E-14
ENSG00000102804	TSC22D1	-0.545	1.47E-13
ENSG00000144355	DLX1	-0.549	1.94E-03
ENSG00000169184	MN1	-0.549	2.49E-09
ENSG00000143507	DUSP10	-0.551	4.91E-05
ENSG00000119938	PPP1R3C	-0.558	2.70E-03
ENSG00000178573	MAF	-0.559	1.84E-02
ENSG00000169715	MT1E	-0.559	7.69E-12
ENSG00000170577	SIX2	-0.562	1.19E-07
ENSG00000197182	MIRLET7BHG	-0.567	9.45E-04
ENSG00000185112	FAM43A	-0.572	4.21E-04
ENSG00000125845	BMP2	-0.576	6.71E-11
ENSG00000173848	NET1	-0.595	2.95E-15
ENSG00000148841	ITPRIP	-0.596	3.08E-12

ENSG00000184678	HIST2H2BE	-0.599	4.13E-03
ENSG00000125398	SOX9	-0.603	3.34E-09
ENSG00000153234	NR4A2	-0.607	3.97E-04
ENSG00000152518	ZFP36L2	-0.609	1.30E-11
ENSG00000106366	SERPINE1	-0.617	1.08E-09
ENSG00000127152	BCL11B	-0.617	5.37E-04
ENSG00000154734	ADAMTS1	-0.618	3.25E-09
ENSG00000173258	ZNF483	-0.625	4.81E-02
ENSG00000019549	SNAI2	-0.631	1.63E-13
ENSG00000164379	FOXQ1	-0.641	1.11E-05
ENSG00000187908	DMBT1	-0.653	3.29E-05
ENSG00000188064	WNT7B	-0.653	4.19E-07
ENSG00000246228	CASC8	-0.666	1.98E-02
ENSG00000123358	NR4A1	-0.666	2.00E-07
ENSG00000115009	CCL20	-0.667	6.68E-08
ENSG00000109321	AREG	-0.673	1.15E-15
ENSG00000268104	SLC6A14	-0.678	8.86E-04
ENSG00000143333	RGS16	-0.681	8.55E-03
ENSG00000125968	ID1	-0.682	5.62E-10
ENSG00000166106	ADAMTS15	-0.683	6.31E-04
ENSG00000142178	SIK1	-0.686	2.37E-02
ENSG00000100628	ASB2	-0.687	1.11E-02
ENSG00000135048	TMEM2	-0.693	5.06E-13
ENSG00000157064	NMNAT2	-0.694	3.08E-02
ENSG00000134259	NGF	-0.699	3.46E-02
ENSG00000106003	LFNG	-0.706	3.31E-05
ENSG00000143816	WNT9A	-0.716	4.90E-08
ENSG00000245848	CEBPA	-0.718	6.84E-04
ENSG00000180730	SHISA2	-0.729	1.15E-03
ENSG00000136997	MYC	-0.731	3.82E-14
ENSG00000087494	PTHLH	-0.735	3.00E-15
ENSG00000140450	ARRDC4	-0.741	2.97E-10
ENSG00000267909	CCDC177	-0.746	1.31E-02
ENSG00000156804	FBXO32	-0.759	1.98E-10
ENSG00000163735	CXCL5	-0.759	2.92E-03
ENSG00000108551	RASD1	-0.760	3.74E-02
ENSG00000183770	FOXL2	-0.771	3.79E-02
ENSG00000185650	ZFP36L1	-0.774	4.13E-17
ENSG00000145358	DDIT4L	-0.775	2.98E-03
ENSG00000095752	IL11	-0.779	3.55E-05
ENSG00000128594	LRRC4	-0.781	6.16E-05
ENSG00000246334	PRR7-AS1	-0.802	1.38E-02
ENSG00000119986	AVPI1	-0.814	2.01E-13

ENSG00000107984	DKK1	-0.822	2.76E-13
ENSG00000138623	SEMA7A	-0.828	2.61E-11
ENSG00000258947	TUBB3	-0.834	1.17E-03
ENSG00000177283	FZD8	-0.835	1.70E-09
ENSG00000176697	BDNF	-0.840	3.19E-03
ENSG00000260260	SNHG19	-0.842	1.10E-02
ENSG00000136244	IL6	-0.877	2.64E-07
ENSG00000123689	G0S2	-0.885	2.37E-17
ENSG00000167772	ANGPTL4	-0.887	7.84E-11
ENSG00000144476	ACKR3	-0.905	1.01E-07
ENSG00000167874	TMEM88	-0.922	1.35E-03
ENSG00000170961	HAS2	-0.948	6.12E-10
ENSG00000174343	CHRNA9	-0.951	9.31E-07
ENSG00000170385	SLC30A1	-0.951	4.43E-15
ENSG00000100985	MMP9	-0.957	3.25E-09
ENSG00000119508	NR4A3	-0.961	2.83E-04
ENSG00000120875	DUSP4	-0.965	4.91E-18
ENSG00000128045	RASL11B	-0.966	3.29E-05
ENSG00000144834	TAGLN3	-0.966	2.42E-04
ENSG00000134363	FST	-0.967	3.00E-15
ENSG00000185338	SOCS1	-1.007	1.25E-03
ENSG00000164949	GEM	-1.068	1.03E-06
ENSG00000188042	ARL4C	-1.093	1.67E-16
ENSG00000178726	THBD	-1.124	8.08E-19
ENSG00000162892	IL24	-1.176	4.86E-11
ENSG00000139874	SSTR1	-1.279	2.45E-05
ENSG00000078401	EDN1	-1.287	6.22E-11
ENSG00000117318	ID3	-1.328	1.93E-16
ENSG00000124216	SNAI1	-1.333	2.42E-11
ENSG00000120129	DUSP1	-1.427	2.31E-20
ENSG00000173391	OLR1	-1.507	1.31E-06
ENSG00000180447	GAS1	-1.516	1.23E-18
ENSG00000189431	RASSF10	-1.533	4.90E-08
ENSG00000116741	RGS2	-1.676	2.95E-18
ENSG00000223361	FTH1P10	-7.439	1.39E-04

Table A4. List of differentially expressed genes (DEGs) control compared to 5U rhPON2 + 50 µM 3-oxo-C_{12}-HSL

Ensembl	Symbol	log_2FC	P.Val
ENSG00000127528	KLF2	1.907	9.79E-08
ENSG00000165507	C10orf10	1.777	1.44E-11
ENSG00000228705	LINC00659	1.408	1.45E-04
ENSG00000204385	SLC44A4	1.397	4.34E-04
ENSG00000157734	SNX22	1.361	1.59E-02
ENSG00000120738	EGR1	1.331	3.69E-18
ENSG00000232810	TNF	1.282	1.09E-02
ENSG00000219891	ZSCAN12P1	1.264	7.02E-06
ENSG00000167995	BEST1	1.210	4.37E-03
ENSG00000172818	OVOL1	1.202	1.38E-12
ENSG00000089692	LAG3	1.192	1.84E-04
ENSG00000172803	SNX32	1.175	7.94E-03
ENSG00000068976	PYGM	1.106	7.63E-03
ENSG00000123610	TNFAIP6	1.094	3.51E-08
ENSG00000139318	DUSP6	1.048	2.53E-19
ENSG00000101306	MYLK2	1.025	2.94E-05
ENSG00000105327	BBC3	1.010	3.73E-08
ENSG00000197279	ZNF165	0.992	1.34E-08
ENSG00000134668	SPOCD1	0.951	1.82E-07
ENSG00000113070	HBEGF	0.951	4.55E-15
ENSG00000203865	ATP1A1-AS1	0.943	2.75E-02
ENSG00000218537	MIF-AS1	0.907	5.86E-03
ENSG00000164400	CSF2	0.893	5.22E-04
ENSG00000111912	NCOA7	0.874	6.66E-14
ENSG00000139354	GAS2L3	0.871	3.79E-12
ENSG00000140451	PIF1	0.856	1.35E-08
ENSG00000123870	ZNF137P	0.855	4.25E-03
ENSG00000123485	HJURP	0.847	9.33E-17
ENSG00000115616	SLC9A2	0.836	2.49E-03
ENSG00000130513	GDF15	0.835	1.61E-04
ENSG00000186480	INSIG1	0.789	8.80E-15
ENSG00000087074	PPP1R15A	0.785	1.35E-13
ENSG00000188766	SPRED3	0.770	1.59E-07
ENSG00000171522	PTGER4	0.763	1.66E-07
ENSG00000073756	PTGS2	0.762	3.08E-10

ENSG00000099974	DDTL	0.753	7.97E-03
ENSG00000124171	PARD6B	0.747	9.43E-06
ENSG00000260941	LINC00622	0.746	1.08E-02
ENSG00000224186	C5orf66	0.744	1.12E-02
ENSG00000109101	FOXN1	0.741	1.65E-02
ENSG00000116285	ERRFI1	0.738	1.98E-15
ENSG00000159588	CCDC17	0.730	2.43E-02
ENSG00000280213	UCKL1-AS1	0.729	1.73E-02
ENSG00000165494	PCF11	0.717	4.55E-15
ENSG00000127507	ADGRE2	0.716	1.03E-02
ENSG00000134222	PSRC1	0.708	1.71E-11
ENSG00000163749	CCDC158	0.706	2.35E-02
ENSG00000270069	MIR222HG	0.706	2.30E-05
ENSG00000166483	WEE1	0.704	3.54E-10
ENSG00000197580	BCO2	0.697	4.50E-02
ENSG00000197647	ZNF433	0.690	2.06E-02
ENSG00000187678	SPRY4	0.675	3.79E-12
ENSG00000140534	TICRR	0.674	1.23E-12
ENSG00000239653	PSMD6-AS2	0.671	7.77E-03
ENSG00000172244	C5orf34	0.666	4.01E-09
ENSG00000173334	TRIB1	0.660	8.22E-11
ENSG00000135407	AVIL	0.657	2.55E-02
ENSG00000141527	CARD14	0.654	3.60E-02
ENSG00000160223	ICOSLG	0.650	1.79E-03
ENSG00000240889	NDUFB2-AS1	0.646	4.46E-02
ENSG00000144655	CSRNP1	0.645	4.38E-10
ENSG00000180953	ST20	0.644	4.01E-02
ENSG00000136167	LCP1	0.643	1.28E-04
ENSG00000121621	KIF18A	0.642	2.67E-10
ENSG00000185262	UBALD2	0.639	7.81E-10
ENSG00000112972	HMGCS1	0.638	4.16E-15
ENSG00000258441	LINC00641	0.631	2.31E-07
ENSG00000162063	CCNF	0.628	9.02E-12
ENSG00000141579	ZNF750	0.625	6.84E-03
ENSG00000198774	RASSF9	0.624	4.47E-06
ENSG00000138778	CENPE	0.619	6.56E-13
ENSG00000172059	KLF11	0.612	3.67E-09
ENSG00000141738	GRB7	0.610	5.05E-09
ENSG00000134107	BHLHE40	0.610	3.79E-12
ENSG00000197857	ZNF44	0.608	2.20E-05
ENSG00000179388	EGR3	0.606	1.37E-06
ENSG00000167565	SERTAD3	0.602	3.44E-08
ENSG00000085465	OVGP1	0.599	9.29E-03

ENSG00000099251	HSD17B7P2	0.597	1.68E-02
ENSG00000198331	HYLS1	0.595	2.44E-08
ENSG00000215784	FAM72D	0.593	3.47E-03
ENSG00000181418	DDN	0.593	2.70E-02
ENSG00000187951	ARHGAP11B	0.590	1.94E-10
ENSG00000157514	TSC22D3	0.590	2.84E-12
ENSG00000126368	NR1D1	0.589	3.54E-10
ENSG00000059804	SLC2A3	0.587	2.96E-08
ENSG00000165259	HDX	0.584	4.53E-03
ENSG00000143847	PPFIA4	0.579	3.99E-04
ENSG00000160888	IER2	0.579	1.54E-09
ENSG00000122644	ARL4A	0.577	5.92E-08
ENSG00000057657	PRDM1	0.572	1.17E-05
ENSG00000052802	MSMO1	0.571	9.68E-12
ENSG00000101447	FAM83D	0.569	1.95E-11
ENSG00000147872	PLIN2	0.568	6.46E-07
ENSG00000164104	HMGB2	0.568	1.10E-12
ENSG00000169018	FEM1B	0.566	1.65E-11
ENSG00000241839	PLEKHO2	0.566	2.00E-07
ENSG00000136122	BORA	0.564	2.17E-08
ENSG00000158055	GRHL3	0.563	3.33E-06
ENSG00000117228	GBP1	0.557	5.71E-09
ENSG00000113161	HMGCR	0.557	9.95E-14
ENSG00000175155	YPEL2	0.549	5.15E-03
ENSG00000128590	DNAJB9	0.549	1.55E-04
ENSG00000184661	CDCA2	0.546	5.81E-11
ENSG00000261556	SMG1P7	0.545	4.33E-03
ENSG00000138835	RGS3	0.544	1.95E-06
ENSG00000196544	BORCS6	0.537	6.74E-04
ENSG00000115163	CENPA	0.536	6.56E-08
ENSG00000182010	RTKN2	0.535	1.19E-02
ENSG00000087586	AURKA	0.534	3.17E-12
ENSG00000196550	FAM72A	0.531	9.72E-05
ENSG00000186185	KIF18B	0.530	3.15E-10
ENSG00000130164	LDLR	0.528	2.72E-12
ENSG00000204618	RNF39	0.528	8.27E-04
ENSG00000134324	LPIN1	0.528	9.68E-12
ENSG00000125657	TNFSF9	0.528	3.42E-02
ENSG00000176532	PRR15	0.523	9.78E-03
ENSG00000123473	STIL	0.521	4.07E-11
ENSG00000146426	TIAM2	0.518	1.33E-02
ENSG00000196611	MMP1	0.517	9.40E-06
ENSG00000121207	LRAT	0.517	1.54E-02

ENSG00000110723	EXPH5	0.515	8.04E-06
ENSG00000213347	MXD3	0.515	1.39E-04
ENSG00000135451	TROAP	0.513	1.84E-09
ENSG00000134690	CDCA8	0.512	4.18E-10
ENSG00000162994	CLHC1	0.508	9.97E-03
ENSG00000137331	IER3	0.507	1.47E-11
ENSG00000184635	ZNF93	0.506	1.71E-03
ENSG00000247095	MIR210HG	0.506	5.37E-04
ENSG00000185215	TNFAIP2	0.501	5.19E-07
ENSG00000138764	CCNG2	0.501	2.92E-09
ENSG00000188610	FAM72B	0.497	3.35E-06
ENSG00000280670	CCDC163P	0.496	2.03E-02
ENSG00000129173	E2F8	0.494	1.85E-08
ENSG00000164414	SLC35A1	0.494	2.66E-02
ENSG00000159208	CIART	0.486	9.90E-04
ENSG00000232653	GOLGA8N	0.486	4.00E-02
ENSG00000204923	FBXO48	0.485	4.57E-03
ENSG00000139190	VAMP1	0.485	1.12E-02
ENSG00000188177	ZC3H6	0.484	7.81E-03
ENSG00000112343	TRIM38	0.483	1.55E-07
ENSG00000135334	AKIRIN2	0.482	1.42E-09
ENSG00000146278	PNRC1	0.482	3.75E-09
ENSG00000204305	AGER	0.481	4.04E-03
ENSG00000169607	CKAP2L	0.478	2.14E-11
ENSG00000196110	ZNF699	0.476	3.07E-03
ENSG00000163661	PTX3	0.475	9.35E-04
ENSG00000164236	ANKRD33B	0.475	5.55E-06
ENSG00000175105	ZNF654	0.474	1.27E-05
ENSG00000128016	ZFP36	0.473	9.56E-11
ENSG00000152359	POC5	0.472	2.55E-07
ENSG00000188206	HNRNPU-AS1	0.472	2.32E-05
ENSG00000225828	FAM229A	0.471	2.08E-02
ENSG00000159388	BTG2	0.468	2.92E-06
ENSG00000128165	ADM2	0.468	7.76E-04
ENSG00000075218	GTSE1	0.467	2.55E-08
ENSG00000119138	KLF9	0.467	1.21E-08
ENSG00000131471	AOC3	0.467	2.57E-02
ENSG00000179593	ALOX15B	0.462	1.64E-02
ENSG00000137462	TLR2	0.461	5.96E-07
ENSG00000137193	PIM1	0.459	1.53E-06
ENSG00000101255	TRIB3	0.457	6.16E-11
ENSG00000272734	ADIRF-AS1	0.456	1.03E-04
ENSG00000152527	PLEKHH2	0.455	5.48E-03

ENSG00000142961	MOB3C	0.450	7.92E-07
ENSG00000153721	CNKSR3	0.449	3.52E-03
ENSG00000197847	SLC22A20	0.448	4.84E-02
ENSG00000171940	ZNF217	0.448	1.02E-11
ENSG00000224660	SH3BP5-AS1	0.447	2.47E-03
ENSG00000154040	CABYR	0.445	4.54E-04
ENSG00000109929	SC5D	0.444	7.35E-09
ENSG00000134339	SAA2	0.442	2.24E-02
ENSG00000011021	CLCN6	0.441	3.24E-07
ENSG00000135441	BLOC1S1	0.440	3.43E-02
ENSG00000024526	DEPDC1	0.439	1.42E-08
ENSG00000162645	GBP2	0.438	8.33E-03
ENSG00000135205	CCDC146	0.438	3.14E-02
ENSG00000213186	TRIM59	0.436	2.60E-05
ENSG00000004777	ARHGAP33	0.435	4.70E-04
ENSG00000173530	TNFRSF10D	0.434	8.17E-10
ENSG00000108932	SLC16A6	0.433	2.91E-02
ENSG00000281183	NPTN-IT1	0.433	4.20E-02
ENSG00000129521	EGLN3	0.429	2.34E-03
ENSG00000185361	TNFAIP8L1	0.426	1.32E-03
ENSG00000064300	NGFR	0.425	1.26E-02
ENSG00000111276	CDKN1B	0.421	3.90E-07
ENSG00000155324	GRAMD3	0.420	1.69E-07
ENSG00000112984	KIF20A	0.418	2.36E-10
ENSG00000148200	NR6A1	0.418	5.00E-02
ENSG00000006634	DBF4	0.417	6.76E-08
ENSG00000042317	SPATA7	0.416	6.75E-03
ENSG00000111860	CEP85L	0.414	1.01E-02
ENSG00000251562	MALAT1	0.413	4.60E-02
ENSG00000160469	BRSK1	0.412	4.71E-02
ENSG00000179750	APOBEC3B	0.411	5.63E-04
ENSG00000131069	ACSS2	0.411	3.75E-09
ENSG00000179820	MYADM	0.411	1.20E-07
ENSG00000066279	ASPM	0.410	8.06E-10
ENSG00000175197	DDIT3	0.409	2.72E-05
ENSG00000032219	ARID4A	0.408	7.57E-06
ENSG00000142677	IL22RA1	0.407	6.69E-04
ENSG00000148773	MKI67	0.407	1.02E-11
ENSG00000166851	PLK1	0.407	2.94E-09
ENSG00000150347	ARID5B	0.405	8.02E-08
ENSG00000100209	HSCB	0.404	1.47E-02
ENSG00000148339	SLC25A25	0.404	1.42E-04
ENSG00000162702	ZNF281	0.404	1.33E-08

ENSG00000163535	SGOL2	0.404	3.49E-07
ENSG00000197822	OCLN	0.403	5.43E-06
ENSG00000170852	KBTBD2	0.401	1.38E-08
ENSG00000110921	MVK	0.401	6.07E-07
ENSG00000129566	TEP1	0.399	5.09E-07
ENSG00000149503	INCENP	0.399	7.91E-10
ENSG00000092140	G2E3	0.394	7.57E-06
ENSG00000223573	TINCR	0.394	2.87E-02
ENSG00000230006	ANKRD36BP2	0.394	2.56E-02
ENSG00000167604	NFKBID	0.393	9.02E-04
ENSG00000237649	KIFC1	0.393	7.85E-10
ENSG00000184574	LPAR5	0.392	1.54E-04
ENSG00000125898	FAM110A	0.391	2.10E-05
ENSG00000245849	RAD51-AS1	0.391	3.89E-02
ENSG00000049769	PPP1R3F	0.391	4.26E-02
ENSG00000137807	KIF23	0.390	2.69E-10
ENSG00000132196	HSD17B7	0.389	1.45E-03
ENSG00000144445	KANSL1L	0.388	7.94E-03
ENSG00000171295	ZNF440	0.388	1.05E-03
ENSG00000113739	STC2	0.387	5.50E-11
ENSG00000109674	NEIL3	0.387	1.76E-05
ENSG00000167785	ZNF558	0.386	8.00E-03
ENSG00000115548	KDM3A	0.386	3.61E-08
ENSG00000138376	BARD1	0.385	1.81E-04
ENSG00000158315	RHBDL2	0.384	1.56E-02
ENSG00000163053	SLC16A14	0.384	9.75E-03
ENSG00000269858	EGLN2	0.382	8.93E-03
ENSG00000111816	FRK	0.381	6.42E-03
ENSG00000136108	CKAP2	0.380	3.06E-09
ENSG00000204650	CRHR1-IT1	0.379	9.63E-03
ENSG00000122483	CCDC18	0.378	7.57E-06
ENSG00000081320	STK17B	0.377	1.09E-06
ENSG00000144802	NFKBIZ	0.377	5.46E-05
ENSG00000100906	NFKBIA	0.376	1.44E-09
ENSG00000188786	MTF1	0.376	5.15E-08
ENSG00000197261	C6orf141	0.375	1.75E-03
ENSG00000112029	FBXO5	0.374	7.05E-08
ENSG00000088854	C20orf194	0.374	2.96E-06
ENSG00000198185	ZNF334	0.373	3.78E-02
ENSG00000148926	ADM	0.371	3.73E-04
ENSG00000091656	ZFHX4	0.371	1.74E-02
ENSG00000088305	DNMT3B	0.370	3.22E-03
ENSG00000166398	KIAA0355	0.370	7.23E-05

ENSG00000120832	MTERF2	0.369	8.34E-03
ENSG00000143013	LMO4	0.369	1.20E-06
ENSG00000079335	CDC14A	0.369	2.01E-02
ENSG00000078900	TP73	0.367	1.93E-02
ENSG00000163961	RNF168	0.367	6.30E-06
ENSG00000137145	DENND4C	0.366	2.52E-07
ENSG00000164211	STARD4	0.365	3.62E-06
ENSG00000168386	FILIP1L	0.365	7.02E-04
ENSG00000128965	CHAC1	0.365	1.47E-05
ENSG00000183621	ZNF438	0.360	5.79E-03
ENSG00000138380	CARF	0.359	3.63E-02
ENSG00000138061	CYP1B1	0.359	1.05E-09
ENSG00000229320	KRT8P12	0.359	3.94E-02
ENSG00000131797	CLUHP3	0.358	6.35E-04
ENSG00000085276	MECOM	0.358	1.47E-03
ENSG00000167508	MVD	0.358	1.56E-07
ENSG00000137135	ARHGEF39	0.357	8.71E-04
ENSG00000147118	ZNF182	0.356	2.53E-03
ENSG00000234444	ZNF736	0.355	1.38E-02
ENSG00000169155	ZBTB43	0.354	1.11E-06
ENSG00000117724	CENPF	0.354	2.40E-10
ENSG00000151012	SLC7A11	0.354	1.15E-06
ENSG00000169908	TM4SF1	0.354	3.74E-06
ENSG00000126562	WNK4	0.353	2.39E-02
ENSG00000176928	GCNT4	0.352	4.51E-02
ENSG00000130766	SESN2	0.352	3.38E-06
ENSG00000112742	TTK	0.352	6.63E-08
ENSG00000068028	RASSF1	0.351	6.92E-06
ENSG00000160570	DEDD2	0.350	3.70E-05
ENSG00000112658	SRF	0.350	3.15E-06
ENSG00000180626	ZNF594	0.349	4.25E-02
ENSG00000146232	NFKBIE	0.348	3.17E-04
ENSG00000145241	CENPC	0.346	1.43E-03
ENSG00000113916	BCL6	0.345	2.45E-04
ENSG00000100100	PIK3IP1	0.342	1.33E-03
ENSG00000109046	WSB1	0.342	1.51E-06
ENSG00000117226	GBP3	0.342	5.47E-05
ENSG00000163082	SGPP2	0.341	7.06E-03
ENSG00000010318	PHF7	0.339	2.72E-02
ENSG00000185436	IFNLR1	0.339	1.96E-03
ENSG00000080986	NDC80	0.337	1.87E-06
ENSG00000174501	ANKRD36C	0.336	4.11E-02
ENSG00000149591	TAGLN	0.336	7.42E-05

ENSG00000120334	CENPL	0.336	4.11E-06
ENSG00000162927	PUS10	0.335	4.10E-02
ENSG00000228223	HCG11	0.335	1.34E-02
ENSG00000101670	LIPG	0.335	1.78E-05
ENSG00000116852	KIF21B	0.334	1.78E-03
ENSG00000120868	APAF1	0.333	1.01E-04
ENSG00000179604	CDC42EP4	0.333	6.46E-07
ENSG00000138166	DUSP5	0.333	4.83E-05
ENSG00000143367	TUFT1	0.333	2.82E-06
ENSG00000005238	FAM214B	0.330	6.80E-06
ENSG00000081019	RSBN1	0.329	1.80E-04
ENSG00000187266	EPOR	0.329	4.71E-02
ENSG00000135365	PHF21A	0.328	5.53E-06
ENSG00000167703	SLC43A2	0.328	9.99E-05
ENSG00000118523	CTGF	0.327	6.42E-04
ENSG00000013441	CLK1	0.327	2.82E-06
ENSG00000206337	HCP5	0.326	5.00E-03
ENSG00000116273	PHF13	0.325	2.42E-06
ENSG00000129355	CDKN2D	0.325	1.57E-02
ENSG00000145779	TNFAIP8	0.325	6.10E-06
ENSG00000117616	RSRP1	0.323	7.74E-05
ENSG00000051108	HERPUD1	0.323	9.93E-07
ENSG00000182919	C11orf54	0.322	3.11E-02
ENSG00000198826	ARHGAP11A	0.322	8.31E-08
ENSG00000079435	LIPE	0.322	4.18E-03
ENSG00000113369	ARRDC3	0.321	3.17E-05
ENSG00000138639	ARHGAP24	0.321	8.76E-04
ENSG00000100344	PNPLA3	0.320	4.84E-02
ENSG00000130695	CEP85	0.318	8.70E-07
ENSG00000269821	KCNQ1OT1	0.317	3.13E-03
ENSG00000184898	RBM43	0.316	2.99E-02
ENSG00000068137	PLEKHH3	0.314	2.40E-04
ENSG00000073712	FERMT2	0.313	2.13E-07
ENSG00000164463	CREBRF	0.311	1.78E-02
ENSG00000117650	NEK2	0.311	1.28E-05
ENSG00000124762	CDKN1A	0.310	1.10E-07
ENSG00000163660	CCNL1	0.308	1.21E-06
ENSG00000152926	ZNF117	0.307	4.95E-02
ENSG00000165861	ZFYVE1	0.307	2.46E-03
ENSG00000204569	PPP1R10	0.307	1.10E-08
ENSG00000165030	NFIL3	0.305	1.62E-05
ENSG00000157554	ERG	0.304	4.86E-02
ENSG00000118620	ZNF430	0.304	2.72E-03

ENSG00000173575	CHD2	0.304	2.08E-08
ENSG00000127666	TICAM1	0.303	4.14E-04
ENSG00000225630	MTND2P28	0.303	2.05E-02
ENSG00000109618	SEPSECS	0.302	5.44E-03
ENSG00000147050	KDM6A	0.302	3.11E-05
ENSG00000198873	GRK5	0.302	1.36E-02
ENSG00000137812	CASC5	0.301	1.91E-07
ENSG00000141682	PMAIP1	0.301	4.01E-04
ENSG00000072864	NDE1	0.301	5.45E-07
ENSG00000145014	TMEM44	0.299	1.44E-02
ENSG00000100968	NFATC4	0.298	4.28E-02
ENSG00000136492	BRIP1	0.297	1.17E-06
ENSG00000170949	ZNF160	0.297	4.54E-04
ENSG00000188315	C3orf62	0.296	5.61E-03
ENSG00000153933	DGKE	0.296	2.02E-03
ENSG00000123080	CDKN2C	0.296	1.90E-03
ENSG00000161642	ZNF385A	0.296	1.98E-06
ENSG00000105483	CARD8	0.296	2.02E-02
ENSG00000151612	ZNF827	0.295	2.89E-04
ENSG00000052344	PRSS8	0.294	2.87E-04
ENSG00000154310	TNIK	0.293	3.41E-02
ENSG00000185158	LRRC37B	0.291	3.86E-02
ENSG00000165548	TMEM63C	0.291	4.60E-02
ENSG00000142945	KIF2C	0.291	1.66E-07
ENSG00000183742	MACC1	0.290	3.49E-02
ENSG00000047346	FAM214A	0.290	1.49E-03
ENSG00000135503	ACVR1B	0.290	1.54E-05
ENSG00000101493	ZNF516	0.290	9.51E-04
ENSG00000078403	MLLT10	0.289	1.93E-05
ENSG00000169679	BUB1	0.288	1.66E-07
ENSG00000161692	DBF4B	0.288	2.01E-04
ENSG00000152457	DCLRE1C	0.286	1.07E-03
ENSG00000114796	KLHL24	0.286	1.84E-02
ENSG00000008086	CDKL5	0.286	5.56E-04
ENSG00000153487	ING1	0.286	8.60E-04
ENSG00000073711	PPP2R3A	0.285	1.17E-03
ENSG00000111665	CDCA3	0.284	3.66E-05
ENSG00000168143	FAM83B	0.284	2.10E-05
ENSG00000132334	PTPRE	0.284	5.40E-06
ENSG00000165115	KIF27	0.284	4.90E-02
ENSG00000059728	MXD1	0.284	3.33E-04
ENSG00000119397	CNTRL	0.283	8.77E-05
ENSG00000186088	GSAP	0.283	6.70E-03

ENSG00000129007	CALML4	0.283	2.43E-02
ENSG00000155090	KLF10	0.282	3.78E-06
ENSG00000165244	ZNF367	0.282	1.02E-04
ENSG00000180667	YOD1	0.281	1.42E-05
ENSG00000073331	ALPK1	0.281	3.84E-03
ENSG00000125347	IRF1	0.281	1.06E-04
ENSG00000142867	BCL10	0.281	6.10E-05
ENSG00000139182	CLSTN3	0.281	7.93E-04
ENSG00000214425	LRRC37A4P	0.280	3.87E-02
ENSG00000100802	C14orf93	0.280	7.06E-03
ENSG00000150991	UBC	0.280	3.25E-06
ENSG00000099992	TBC1D10A	0.279	3.30E-02
ENSG00000160685	ZBTB7B	0.279	1.04E-04
ENSG00000101751	POLI	0.278	1.36E-02
ENSG00000181827	RFX7	0.277	3.59E-06
ENSG00000160588	MPZL3	0.277	1.68E-03
ENSG00000156313	RPGR	0.276	3.08E-02
ENSG00000188493	C19orf54	0.276	1.57E-02
ENSG00000124688	MAD2L1BP	0.276	7.44E-04
ENSG00000151065	DCP1B	0.275	8.01E-03
ENSG00000177045	SIX5	0.274	1.88E-04
ENSG00000156970	BUB1B	0.274	1.04E-06
ENSG00000168769	TET2	0.274	2.05E-04
ENSG00000176046	NUPR1	0.273	1.17E-03
ENSG00000132005	RFX1	0.273	2.07E-02
ENSG00000145365	TIFA	0.272	2.57E-02
ENSG00000198780	FAM169A	0.271	6.70E-03
ENSG00000138688	KIAA1109	0.271	6.01E-06
ENSG00000104427	ZC2HC1A	0.271	1.65E-02
ENSG00000103852	TTC23	0.271	6.81E-03
ENSG00000131149	GSE1	0.271	6.91E-05
ENSG00000127328	RAB3IP	0.271	5.63E-04
ENSG00000187091	PLCD1	0.270	5.18E-03
ENSG00000187772	LIN28B	0.270	2.17E-02
ENSG00000196369	SRGAP2B	0.270	4.53E-03
ENSG00000143457	GOLPH3L	0.270	2.44E-03
ENSG00000185920	PTCH1	0.270	2.41E-02
ENSG00000182831	C16orf72	0.270	2.55E-05
ENSG00000080546	SESN1	0.269	8.64E-03
ENSG00000112983	BRD8	0.269	9.49E-07
ENSG00000145911	N4BP3	0.269	1.96E-03
ENSG00000140743	CDR2	0.268	1.68E-04
ENSG00000184863	RBM33	0.268	1.44E-06

ENSG00000143622	RIT1	0.268	3.44E-04
ENSG00000127452	FBXL12	0.267	3.17E-03
ENSG00000177000	MTHFR	0.266	1.25E-03
ENSG00000162783	IER5	0.266	3.66E-05
ENSG00000172840	PDP2	0.265	4.90E-04
ENSG00000104221	BRF2	0.265	2.81E-02
ENSG00000110318	CEP126	0.265	5.69E-03
ENSG00000213390	ARHGAP19	0.265	3.47E-03
ENSG00000240230	COX19	0.264	5.24E-04
ENSG00000112096	SOD2	0.264	7.21E-04
ENSG00000107372	ZFAND5	0.264	3.02E-05
ENSG00000173041	ZNF680	0.264	1.44E-02
ENSG00000166750	SLFN5	0.264	1.17E-06
ENSG00000172732	MUS81	0.263	1.70E-04
ENSG00000213047	DENND1B	0.263	2.43E-02
ENSG00000078699	CBFA2T2	0.263	8.23E-05
ENSG00000170919	TPT1-AS1	0.262	4.86E-02
ENSG00000143228	NUF2	0.262	2.11E-04
ENSG00000050327	ARHGEF5	0.262	3.39E-04
ENSG00000170485	NPAS2	0.261	6.82E-04
ENSG00000166004	CEP295	0.261	1.21E-04
ENSG00000126787	DLGAP5	0.261	1.54E-05
ENSG00000213516	RBMXL1	0.261	1.78E-04
ENSG00000104313	EYA1	0.260	4.46E-02
ENSG00000148737	TCF7L2	0.260	1.47E-04
ENSG00000204644	ZFP57	0.260	5.77E-05
ENSG00000105877	DNAH11	0.259	4.15E-02
ENSG00000161800	RACGAP1	0.258	1.30E-06
ENSG00000156787	TBC1D31	0.257	2.13E-03
ENSG00000168795	ZBTB5	0.257	4.01E-04
ENSG00000272888	LINC01578	0.257	4.89E-02
ENSG00000139132	FGD4	0.257	2.72E-04
ENSG00000137075	RNF38	0.257	1.07E-03
ENSG00000138182	KIF20B	0.257	3.86E-06
ENSG00000169429	CXCL8	0.257	5.94E-04
ENSG00000172086	KRCC1	0.256	9.56E-04
ENSG00000196652	ZKSCAN5	0.256	1.69E-04
ENSG00000165782	TMEM55B	0.256	2.28E-03
ENSG00000088325	TPX2	0.256	1.61E-08
ENSG00000109220	CHIC2	0.255	7.51E-03
ENSG00000014914	MTMR11	0.254	1.72E-02
ENSG00000133619	KRBA1	0.254	1.83E-02
ENSG00000164331	ANKRA2	0.254	1.01E-02

ENSG00000169174	PCSK9	0.254	3.82E-04
ENSG00000197329	PELI1	0.253	4.68E-04
ENSG00000125798	FOXA2	0.253	2.89E-02
ENSG00000134909	ARHGAP32	0.252	4.64E-05
ENSG00000114423	CBLB	0.252	4.71E-03
ENSG00000112715	VEGFA	0.252	3.84E-07
ENSG00000115904	SOS1	0.250	4.17E-05
ENSG00000140682	TGFB1I1	0.250	2.92E-03
ENSG00000070159	PTPN3	0.250	5.31E-06
ENSG00000114473	IQCG	0.250	3.26E-02
ENSG00000135378	PRRG4	0.249	3.31E-04
ENSG00000158402	CDC25C	0.249	1.04E-03
ENSG00000177426	TGIF1	0.249	2.91E-04
ENSG00000118518	RNF146	0.249	4.33E-03
ENSG00000128833	MYO5C	0.249	2.45E-02
ENSG00000166037	CEP57	0.248	1.91E-04
ENSG00000242086	LINC00969	0.248	1.03E-02
ENSG00000154370	TRIM11	0.248	1.38E-04
ENSG00000035403	VCL	0.247	1.65E-07
ENSG00000166173	LARP6	0.247	3.49E-02
ENSG00000129195	FAM64A	0.247	2.15E-03
ENSG00000169375	SIN3A	0.247	1.37E-06
ENSG00000178974	FBXO34	0.246	5.56E-04
ENSG00000151474	FRMD4A	0.246	7.66E-03
ENSG00000136158	SPRY2	0.245	7.88E-03
ENSG00000131747	TOP2A	0.245	2.30E-07
ENSG00000102401	ARMCX3	0.245	1.36E-03
ENSG00000118503	TNFAIP3	0.245	1.26E-06
ENSG00000166024	R3HCC1L	0.245	1.85E-03
ENSG00000109084	TMEM97	0.245	1.76E-05
ENSG00000266338	NBPF15	0.245	6.76E-03
ENSG00000181690	PLAG1	0.244	1.73E-02
ENSG00000168137	SETD5	0.242	2.82E-06
ENSG00000088356	PDRG1	0.242	2.06E-03
ENSG00000103642	LACTB	0.242	1.13E-02
ENSG00000174652	ZNF266	0.242	3.28E-02
ENSG00000035499	DEPDC1B	0.242	4.34E-04
ENSG00000198556	ZNF789	0.241	3.96E-02
ENSG00000183856	IQGAP3	0.241	3.90E-05
ENSG00000120616	EPC1	0.241	1.01E-03
ENSG00000166886	NAB2	0.240	8.34E-05
ENSG00000068078	FGFR3	0.240	8.60E-04
ENSG00000105287	PRKD2	0.240	3.30E-04

ENSG00000079432	CIC	0.240	1.25E-04
ENSG00000090339	ICAM1	0.239	2.46E-06
ENSG00000082269	FAM135A	0.239	1.17E-03
ENSG00000086544	ITPKC	0.239	2.28E-03
ENSG00000254470	AP5B1	0.239	8.94E-04
ENSG00000164663	USP49	0.238	2.89E-02
ENSG00000132109	TRIM21	0.238	6.51E-03
ENSG00000185880	TRIM69	0.238	1.34E-02
ENSG00000077458	FAM76B	0.237	1.63E-03
ENSG00000236104	ZBTB22	0.237	4.28E-02
ENSG00000065970	FOXJ2	0.237	4.46E-05
ENSG00000162769	FLVCR1	0.236	4.01E-03
ENSG00000159167	STC1	0.236	2.58E-02
ENSG00000168310	IRF2	0.235	2.47E-03
ENSG00000132535	DLG4	0.235	2.89E-02
ENSG00000177602	GSG2	0.235	9.84E-04
ENSG00000118922	KLF12	0.234	4.46E-03
ENSG00000055609	KMT2C	0.234	1.24E-05
ENSG00000130150	MOSPD2	0.234	1.12E-02
ENSG00000185813	PCYT2	0.234	3.30E-03
ENSG00000198382	UVRAG	0.233	4.07E-03
ENSG00000123636	BAZ2B	0.233	6.04E-05
ENSG00000198585	NUDT16	0.233	1.34E-03
ENSG00000120647	CCDC77	0.233	1.26E-02
ENSG00000142794	NBPF3	0.232	8.68E-03
ENSG00000155158	TTC39B	0.232	2.29E-02
ENSG00000068745	IP6K2	0.232	6.64E-05
ENSG00000156463	SH3RF2	0.232	1.29E-05
ENSG00000163637	PRICKLE2	0.231	1.91E-02
ENSG00000197562	RAB40C	0.231	2.16E-02
ENSG00000179361	ARID3B	0.231	8.18E-04
ENSG00000122779	TRIM24	0.230	2.54E-04
ENSG00000146112	PPP1R18	0.230	1.47E-06
ENSG00000130479	MAP1S	0.230	1.07E-03
ENSG00000176624	MEX3C	0.230	1.14E-04
ENSG00000135241	PNPLA8	0.230	3.71E-03
ENSG00000104093	DMXL2	0.230	1.06E-02
ENSG00000131711	MAP1B	0.230	2.78E-05
ENSG00000082898	XPO1	0.229	3.30E-06
ENSG00000185684	EP400NL	0.229	6.09E-03
ENSG00000121211	MND1	0.229	3.26E-02
ENSG00000011422	PLAUR	0.229	3.01E-04
ENSG00000113319	RASGRF2	0.228	1.49E-02

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ENSG00000168297	PXK	0.227	1.73E-02
ENSG00000109458	GAB1	0.227	2.65E-02
ENSG00000214193	SH3D21	0.227	2.47E-03
ENSG00000100842	EFS	0.227	2.07E-02
ENSG00000174718	KIAA1551	0.227	8.79E-04
ENSG00000169504	CLIC4	0.226	5.61E-05
ENSG00000244405	ETV5	0.226	7.97E-03
ENSG00000179335	CLK3	0.226	2.90E-04
ENSG00000178074	C2orf69	0.226	1.09E-02
ENSG00000090889	KIF4A	0.226	4.79E-04
ENSG00000101574	METTL4	0.226	2.16E-02
ENSG00000143322	ABL2	0.225	1.20E-03
ENSG00000133401	PDZD2	0.224	3.00E-03
ENSG00000079156	OSBPL6	0.224	4.61E-03
ENSG00000140396	NCOA2	0.223	2.19E-03
ENSG00000108389	MTMR4	0.223	4.75E-04
ENSG00000138160	KIF11	0.223	1.20E-05
ENSG00000177125	ZBTB34	0.222	1.92E-02
ENSG00000104447	TRPS1	0.222	8.73E-03
ENSG00000100439	ABHD4	0.222	3.16E-03
ENSG00000100219	XBP1	0.222	2.45E-06
ENSG00000080200	CRYBG3	0.222	4.34E-03
ENSG00000074621	SLC24A1	0.222	3.20E-02
ENSG00000113328	CCNG1	0.222	1.78E-04
ENSG00000183323	CCDC125	0.222	2.97E-02
ENSG00000166801	FAM111A	0.221	5.07E-05
ENSG00000186472	PCLO	0.221	2.21E-03
ENSG00000167595	PROSER3	0.221	2.74E-03
ENSG00000143952	VPS54	0.220	6.20E-03
ENSG00000089916	GPATCH2L	0.220	1.21E-04
ENSG00000117000	RLF	0.220	1.02E-04
ENSG00000123066	MED13L	0.220	4.66E-05
ENSG00000052126	PLEKHA5	0.219	1.93E-04
ENSG00000005483	KMT2E	0.219	4.55E-05
ENSG00000135476	ESPL1	0.219	8.24E-04
ENSG00000067064	IDI1	0.219	2.84E-04
ENSG00000181315	ZNF322	0.218	9.83E-03
ENSG00000163694	RBM47	0.218	1.89E-03
ENSG00000250251	PKD1P6	0.218	4.28E-02
ENSG00000171606	ZNF274	0.218	6.28E-04
ENSG00000116584	ARHGEF2	0.217	6.65E-06

ENSG00000083307	GRHL2	0.216	2.92E-03
ENSG00000167257	RNF214	0.215	1.65E-02
ENSG00000165195	PIGA	0.215	4.43E-03
ENSG00000147874	HAUS6	0.214	4.28E-04
ENSG00000177051	FBXO46	0.214	7.12E-03
ENSG00000131979	GCH1	0.214	6.33E-03
ENSG00000160200	CBS	0.214	3.89E-02
ENSG00000115008	IL1A	0.214	1.20E-04
ENSG00000117461	PIK3R3	0.213	6.23E-03
ENSG00000124496	TRERF1	0.213	2.82E-04
ENSG00000141582	CBX4	0.213	1.08E-03
ENSG00000169118	CSNK1G1	0.213	5.43E-04
ENSG00000163877	SNIP1	0.213	3.50E-03
ENSG00000090924	PLEKHG2	0.212	1.75E-04
ENSG00000159256	MORC3	0.212	2.07E-03
ENSG00000138180	CEP55	0.212	3.75E-05
ENSG00000184384	MAML2	0.212	1.22E-02
ENSG00000183137	CEP57L1	0.212	1.62E-02
ENSG00000197056	ZMYM1	0.212	4.59E-02
ENSG00000188215	DCUN1D3	0.211	4.10E-02
ENSG00000134757	DSG3	0.211	1.05E-04
ENSG00000116991	SIPA1L2	0.211	9.15E-03
ENSG00000167528	ZNF641	0.211	1.96E-02
ENSG00000128944	KNSTRN	0.211	4.01E-04
ENSG00000164951	PDP1	0.210	2.63E-03
ENSG00000121931	LRIF1	0.210	1.68E-03
ENSG00000135837	CEP350	0.210	3.13E-05
ENSG00000076382	SPAG5	0.210	2.61E-04
ENSG00000102384	CENPI	0.210	6.51E-03
ENSG00000205268	PDE7A	0.209	6.50E-03
ENSG00000170340	B3GNT2	0.208	6.40E-03
ENSG00000082458	DLG3	0.207	6.67E-03
ENSG00000197019	SERTAD1	0.207	6.42E-03
ENSG00000163602	RYBP	0.207	1.43E-03
ENSG00000129810	SGOL1	0.207	1.28E-02
ENSG00000147852	VLDLR	0.207	3.49E-02
ENSG00000151151	IPMK	0.206	2.97E-02
ENSG00000085185	BCORL1	0.206	1.82E-02
ENSG00000206538	VGLL3	0.206	3.17E-02
ENSG00000087266	SH3BP2	0.206	3.12E-04
ENSG00000170734	POLH	0.206	4.33E-03
ENSG00000111077	TNS2	0.206	4.86E-04
ENSG00000068305	MEF2A	0.205	9.90E-04

ENSG00000138640	FAM13A	0.205	4.04E-02
ENSG00000149639	SOGA1	0.205	7.22E-05
ENSG00000204138	PHACTR4	0.205	1.69E-04
ENSG00000157657	ZNF618	0.205	7.14E-03
ENSG00000164970	FAM219A	0.205	1.54E-02
ENSG00000172869	DMXL1	0.204	1.22E-03
ENSG00000145386	CCNA2	0.204	1.54E-04
ENSG00000226419	SLC16A1-AS1	0.204	1.16E-02
ENSG00000182504	CEP97	0.203	2.29E-02
ENSG00000153391	INO80C	0.203	3.38E-02
ENSG00000052795	FNIP2	0.202	3.16E-02
ENSG00000146094	DOK3	0.202	3.71E-02
ENSG00000197121	PGAP1	0.202	2.30E-02
ENSG00000006459	KDM7A	0.202	5.47E-03
ENSG00000128283	CDC42EP1	0.202	6.43E-04
ENSG00000146373	RNF217	0.202	5.45E-03
ENSG00000147162	OGT	0.202	8.21E-04
ENSG00000116128	BCL9	0.202	6.21E-03
ENSG00000198646	NCOA6	0.201	3.38E-05
ENSG00000134057	CCNB1	0.201	3.28E-04
ENSG00000118193	KIF14	0.201	5.30E-04
ENSG00000070731	ST6GALNAC2	0.201	2.51E-02
ENSG00000070495	JMJD6	0.201	6.19E-03
ENSG00000163516	ANKZF1	0.201	6.58E-03
ENSG00000178951	ZBTB7A	0.201	5.44E-04
ENSG00000185499	MUC1	0.200	5.88E-03
ENSG00000122741	DCAF10	0.200	4.53E-03
ENSG00000119906	SLF2	0.199	1.08E-03
ENSG00000124523	SIRT5	0.199	2.56E-02
ENSG00000100376	FAM118A	0.199	2.44E-02
ENSG00000278311	GGNBP2	0.199	5.87E-05
ENSG00000183696	UPP1	0.199	1.21E-05
ENSG00000108799	EZH1	0.199	1.80E-02
ENSG00000157796	WDR19	0.199	1.47E-02
ENSG00000124596	OARD1	0.199	2.11E-02
ENSG00000117758	STX12	0.198	6.88E-03
ENSG00000168389	MFSD2A	0.198	2.95E-04
ENSG00000165288	BRWD3	0.198	1.76E-03
ENSG00000139618	BRCA2	0.198	4.94E-04
ENSG00000186532	SMYD4	0.198	1.23E-02
ENSG00000103061	SLC7A6OS	0.198	6.04E-03
ENSG00000142731	PLK4	0.197	1.78E-04
ENSG00000151929	BAG3	0.197	1.76E-05

ENSG00000154642	C21orf91	0.197	4.16E-02
ENSG00000096717	SIRT1	0.197	7.66E-03
ENSG00000047230	CTPS2	0.197	2.01E-02
ENSG00000013810	TACC3	0.196	7.94E-05
ENSG00000103657	HERC1	0.196	3.18E-03
ENSG00000070476	ZXDC	0.196	1.53E-02
ENSG00000117500	TMED5	0.195	1.41E-03
ENSG00000132357	CARD6	0.195	5.58E-03
ENSG00000112406	HECA	0.195	1.38E-02
ENSG00000054282	SDCCAG8	0.195	1.86E-02
ENSG00000196705	ZNF431	0.195	2.93E-02
ENSG00000072571	HMMR	0.195	1.19E-03
ENSG00000189079	ARID2	0.194	1.14E-03
ENSG00000121957	GPSM2	0.194	1.69E-04
ENSG00000116717	GADD45A	0.194	5.66E-04
ENSG00000110619	CARS	0.194	2.79E-04
ENSG00000131779	PEX11B	0.194	2.63E-02
ENSG00000132950	ZMYM5	0.194	3.55E-02
ENSG00000166446	CDYL2	0.194	3.84E-02
ENSG00000172071	EIF2AK3	0.194	2.80E-02
ENSG00000205189	ZBTB10	0.193	1.91E-02
ENSG00000048649	RSF1	0.193	3.27E-04
ENSG00000173614	NMNAT1	0.193	3.98E-02
ENSG00000129534	MIS18BP1	0.192	4.61E-03
ENSG00000116580	GON4L	0.192	7.90E-04
ENSG00000165209	STRBP	0.192	2.07E-02
ENSG00000051825	MPHOSPH9	0.192	9.82E-03
ENSG00000245532	NEAT1	0.192	4.18E-02
ENSG00000130856	ZNF236	0.191	2.09E-02
ENSG00000157456	CCNB2	0.191	2.27E-04
ENSG00000158079	PTPDC1	0.191	1.43E-02
ENSG00000198431	TXNRD1	0.191	5.79E-04
ENSG00000171943	SRGAP2C	0.190	4.61E-02
ENSG00000167842	MIS12	0.190	7.28E-03
ENSG00000154429	CCSAP	0.190	4.79E-02
ENSG00000110851	PRDM4	0.190	7.02E-04
ENSG00000141219	C17orf80	0.189	1.90E-02
ENSG00000139083	ETV6	0.189	1.18E-03
ENSG00000142599	RERE	0.189	2.82E-04
ENSG00000157450	RNF111	0.188	1.07E-03
ENSG00000107882	SUFU	0.188	2.21E-02
ENSG00000196187	TMEM63A	0.188	3.86E-02
ENSG00000135999	EPC2	0.188	8.68E-03

ENSG00000151883	PARP8	0.188	2.69E-02
ENSG00000116044	NFE2L2	0.187	4.87E-05
ENSG00000080802	CNOT4	0.187	7.08E-04
ENSG00000183735	TBK1	0.187	4.08E-03
ENSG00000171223	JUNB	0.187	3.00E-03
ENSG00000115459	ELMOD3	0.187	4.79E-02
ENSG00000173209	AHSA2	0.187	4.06E-02
ENSG00000183955	SETD8	0.187	2.03E-04
ENSG00000166484	MAPK7	0.187	1.67E-02
ENSG00000188158	NHS	0.186	4.26E-02
ENSG00000113368	LMNB1	0.186	8.55E-05
ENSG00000074935	TUBE1	0.186	4.06E-02
ENSG00000149212	SESN3	0.185	1.20E-02
ENSG00000108506	INTS2	0.185	2.46E-02
ENSG00000147383	NSDHL	0.185	4.70E-03
ENSG00000141446	ESCO1	0.184	5.53E-03
ENSG00000154237	LRRK1	0.184	6.61E-03
ENSG00000152409	JMY	0.184	2.55E-02
ENSG00000129353	SLC44A2	0.184	1.31E-04
ENSG00000266074	BAHCC1	0.183	2.69E-02
ENSG00000077157	PPP1R12B	0.183	2.88E-02
ENSG00000100092	SH3BP1	0.183	1.43E-03
ENSG00000101745	ANKRD12	0.182	4.23E-03
ENSG00000153914	SREK1	0.182	4.41E-04
ENSG00000228253	MT-ATP8	0.182	3.77E-02
ENSG00000179833	SERTAD2	0.182	1.60E-03
ENSG00000178996	SNX18	0.182	1.11E-02
ENSG00000178295	GEN1	0.181	6.03E-03
ENSG00000168944	CEP120	0.181	6.80E-03
ENSG00000012817	KDM5D	0.181	2.58E-02
ENSG00000101577	LPIN2	0.181	4.71E-02
ENSG00000110925	CSRNP2	0.181	2.08E-03
ENSG00000151748	SAV1	0.180	5.57E-03
ENSG00000186814	ZSCAN30	0.180	3.12E-02
ENSG00000115020	PIKFYVE	0.180	5.38E-03
ENSG00000236287	ZBED5	0.180	3.24E-03
ENSG00000152217	SETBP1	0.180	4.12E-02
ENSG00000198901	PRC1	0.180	1.04E-04
ENSG00000197961	ZNF121	0.180	1.12E-02
ENSG00000107771	CCSER2	0.180	8.77E-03
ENSG00000167460	TPM4	0.179	4.11E-06
ENSG00000154839	SKA1	0.179	2.01E-03
ENSG00000167657	DAPK3	0.179	4.67E-03

ENSG00000116127	ALMS1	0.178	1.07E-03
ENSG00000109381	ELF2	0.178	1.11E-02
ENSG00000121879	PIK3CA	0.178	9.78E-03
ENSG00000135749	PCNXL2	0.177	1.74E-02
ENSG00000188895	MSL1	0.177	2.23E-04
ENSG00000166845	C18orf54	0.177	2.69E-02
ENSG00000143815	LBR	0.177	4.35E-03
ENSG00000128274	A4GALT	0.177	2.42E-02
ENSG00000139278	GLIPR1	0.177	1.61E-02
ENSG00000180011	ZADH2	0.177	4.12E-03
ENSG00000164190	NIPBL	0.176	3.27E-05
ENSG00000198707	CEP290	0.176	2.56E-02
ENSG00000003402	CFLAR	0.176	4.54E-04
ENSG00000205885	C1RL-AS1	0.176	2.55E-02
ENSG00000115966	ATF2	0.176	1.04E-02
ENSG00000100578	KIAA0586	0.176	1.89E-02
ENSG00000113810	SMC4	0.176	4.77E-04
ENSG00000116205	TCEANC2	0.175	3.51E-02
ENSG00000100014	SPECC1L	0.175	9.82E-03
ENSG00000173273	TNKS	0.175	1.45E-03
ENSG00000077684	JADE1	0.175	2.48E-02
ENSG00000198160	MIER1	0.175	5.90E-03
ENSG00000175455	CCDC14	0.175	6.66E-03
ENSG00000146872	TLK2	0.174	4.07E-03
ENSG00000105879	CBLL1	0.174	1.07E-03
ENSG00000088179	PTPN4	0.174	3.79E-02
ENSG00000104936	DMPK	0.174	4.88E-02
ENSG00000177853	ZNF518A	0.174	1.75E-02
ENSG00000140382	HMG20A	0.174	1.16E-02
ENSG00000128272	ATF4	0.174	1.42E-05
ENSG00000177200	CHD9	0.173	4.18E-04
ENSG00000128881	TTBK2	0.173	6.25E-03
ENSG00000135164	DMTF1	0.173	1.73E-03
ENSG00000104413	ESRP1	0.173	3.44E-04
ENSG00000119669	IRF2BPL	0.173	2.03E-03
ENSG00000134744	ZCCHC11	0.172	3.17E-03
ENSG00000141232	TOB1	0.172	1.20E-02
ENSG00000166123	GPT2	0.172	4.64E-03
ENSG00000111012	CYP27B1	0.171	1.39E-02
ENSG00000188827	SLX4	0.171	3.19E-02
ENSG00000054965	FAM168A	0.170	3.43E-03
ENSG00000171206	TRIM8	0.170	4.33E-03
ENSG00000163874	ZC3H12A	0.170	1.73E-03

ENSG00000133858	ZFC3H1	0.170	3.44E-03
ENSG00000167173	C15orf39	0.170	6.05E-03
ENSG00000176018	LYSMD3	0.169	2.63E-02
ENSG00000072778	ACADVL	0.169	4.18E-04
ENSG00000067082	KLF6	0.169	3.34E-04
ENSG00000136152	COG3	0.169	7.37E-03
ENSG00000186871	ERCC6L	0.169	2.69E-02
ENSG00000143067	ZNF697	0.169	2.04E-02
ENSG00000122966	CIT	0.169	6.82E-04
ENSG00000010322	NISCH	0.168	1.01E-02
ENSG00000171492	LRRC8D	0.168	2.46E-02
ENSG00000137601	NEK1	0.168	2.25E-02
ENSG00000197063	MAFG	0.168	1.38E-02
ENSG00000114520	SNX4	0.168	3.28E-02
ENSG00000112763	BTN2A1	0.167	1.48E-02
ENSG00000197321	SVIL	0.167	6.77E-04
ENSG00000122257	RBBP6	0.167	2.50E-04
ENSG00000173064	HECTD4	0.167	1.04E-02
ENSG00000101004	NINL	0.167	4.78E-02
ENSG00000198408	MGEA5	0.167	1.76E-04
ENSG00000133606	MKRN1	0.166	6.34E-03
ENSG00000188994	ZNF292	0.166	5.52E-03
ENSG00000101191	DIDO1	0.166	3.36E-04
ENSG00000188559	RALGAPA2	0.166	5.19E-03
ENSG00000064666	CNN2	0.166	5.59E-04
ENSG00000164284	GRPEL2	0.166	1.51E-02
ENSG00000100852	ARHGAP5	0.165	2.62E-03
ENSG00000158321	AUTS2	0.165	4.15E-02
ENSG00000120437	ACAT2	0.165	8.62E-04
ENSG00000100523	DDHD1	0.165	4.14E-02
ENSG00000165359	DDX26B	0.165	4.83E-02
ENSG00000051009	FAM160A2	0.164	4.16E-02
ENSG00000143033	MTF2	0.164	1.46E-02
ENSG00000239305	RNF103	0.164	4.10E-02
ENSG00000170365	SMAD1	0.164	3.15E-02
ENSG00000196182	STK40	0.163	1.47E-02
ENSG00000165322	ARHGAP12	0.163	2.28E-02
ENSG00000001460	STPG1	0.163	3.78E-02
ENSG00000183765	CHEK2	0.163	3.08E-02
ENSG00000186638	KIF24	0.162	3.01E-02
ENSG00000135842	FAM129A	0.162	1.18E-02
ENSG00000075391	RASAL2	0.162	8.56E-03
ENSG00000109920	FNBP4	0.161	1.11E-03

ENSG00000162852	CNST	0.161	4.43E-02
ENSG00000110906	KCTD10	0.161	6.13E-04
ENSG00000010292	NCAPD2	0.161	4.33E-04
ENSG00000154760	SLFN13	0.160	2.13E-03
ENSG00000108599	AKAP10	0.160	4.19E-02
ENSG00000112130	RNF8	0.160	2.91E-02
ENSG00000165997	ARL5B	0.160	3.50E-02
ENSG00000040933	INPP4A	0.160	4.85E-02
ENSG00000154229	PRKCA	0.160	4.51E-02
ENSG00000198586	TLK1	0.160	4.09E-03
ENSG00000114120	SLC25A36	0.160	9.14E-03
ENSG00000197147	LRRC8B	0.160	3.23E-02
ENSG00000105325	FZR1	0.159	2.37E-02
ENSG00000196935	SRGAP1	0.159	3.03E-02
ENSG00000134294	SLC38A2	0.159	4.62E-04
ENSG00000152133	GPATCH11	0.159	3.39E-02
ENSG00000121741	ZMYM2	0.158	2.04E-03
ENSG00000198924	DCLRE1A	0.158	5.04E-02
ENSG00000130703	OSBPL2	0.158	8.55E-03
ENSG00000171241	SHCBP1	0.158	1.49E-02
ENSG00000119844	AFTPH	0.158	1.88E-02
ENSG00000136715	SAP130	0.157	1.14E-02
ENSG00000101040	ZMYND8	0.157	1.78E-04
ENSG00000110911	SLC11A2	0.157	2.38E-02
ENSG00000159348	CYB5R1	0.157	8.06E-03
ENSG00000181467	RAP2B	0.156	3.61E-03
ENSG00000156860	FBRS	0.156	4.43E-03
ENSG00000159314	ARHGAP27	0.155	3.55E-02
ENSG00000152520	PAN3	0.155	2.75E-02
ENSG00000118058	KMT2A	0.155	3.88E-03
ENSG00000184292	TACSTD2	0.154	4.84E-04
ENSG00000157625	TAB3	0.154	9.38E-04
ENSG00000198315	ZKSCAN8	0.154	7.85E-03
ENSG00000198198	SZT2	0.154	1.15E-02
ENSG00000143614	GATAD2B	0.153	8.00E-03
ENSG00000120539	MASTL	0.153	7.60E-03
ENSG00000109062	SLC9A3R1	0.153	1.98E-02
ENSG00000198113	TOR4A	0.153	3.28E-02
ENSG00000122482	ZNF644	0.152	7.24E-03
ENSG00000143776	CDC42BPA	0.152	5.04E-03
ENSG00000147133	TAF1	0.152	1.05E-02
ENSG00000164327	RICTOR	0.151	1.31E-02
ENSG00000106462	EZH2	0.151	3.64E-03

ENSG00000075702	WDR62	0.151	4.01E-02
ENSG00000112941	PAPD7	0.151	2.98E-03
ENSG00000083223	ZCCHC6	0.151	1.05E-02
ENSG00000079459	FDFT1	0.151	3.98E-04
ENSG00000055208	TAB2	0.151	8.05E-04
ENSG00000135686	KLHL36	0.151	3.02E-02
ENSG00000177463	NR2C2	0.151	6.20E-03
ENSG00000125875	TBC1D20	0.151	3.07E-03
ENSG00000105443	CYTH2	0.151	1.36E-02
ENSG00000048707	VPS13D	0.151	4.34E-03
ENSG00000174564	IL20RB	0.150	1.15E-03
ENSG00000109805	NCAPG	0.150	4.80E-03
ENSG00000196220	SRGAP3	0.150	2.46E-02
ENSG00000170037	CNTROB	0.150	1.04E-02
ENSG00000145390	USP53	0.150	1.21E-02
ENSG00000166348	USP54	0.150	4.58E-02
ENSG00000131669	NINJ1	0.149	4.78E-02
ENSG00000198742	SMURF1	0.149	3.49E-03
ENSG00000189180	ZNF33A	0.149	2.08E-02
ENSG00000141298	SSH2	0.149	2.57E-02
ENSG00000166783	KIAA0430	0.148	2.03E-02
ENSG00000132680	KIAA0907	0.148	2.29E-02
ENSG00000170871	KIAA0232	0.147	2.50E-02
ENSG00000161638	ITGA5	0.147	3.60E-03
ENSG00000135473	PAN2	0.147	3.12E-02
ENSG00000119801	YPEL5	0.147	2.79E-02
ENSG00000168522	FNTA	0.147	2.71E-02
ENSG00000172893	DHCR7	0.146	1.59E-02
ENSG00000170776	AKAP13	0.146	4.43E-03
ENSG00000078246	TULP3	0.146	4.71E-02
ENSG00000107554	DNMBP	0.146	4.00E-03
ENSG00000106571	GLI3	0.145	4.59E-02
ENSG00000146830	GIGYF1	0.145	2.11E-02
ENSG00000100485	SOS2	0.145	2.10E-02
ENSG00000183963	SMTN	0.145	1.69E-02
ENSG00000176102	CSTF3	0.145	2.18E-02
ENSG00000212907	MT-ND4L	0.144	2.39E-02
ENSG00000172661	FAM21C	0.144	4.28E-02
ENSG00000134982	APC	0.144	1.40E-03
ENSG00000170113	NIPA1	0.144	4.87E-02
ENSG00000173327	MAP3K11	0.144	2.39E-02
ENSG00000143514	TP53BP2	0.144	1.79E-02
ENSG00000135945	REV1	0.143	3.62E-02

ENSG00000184205	TSPYL2	0.143	2.26E-02
ENSG00000163110	PDLIM5	0.143	4.33E-03
ENSG00000175063	UBE2C	0.143	2.06E-03
ENSG00000118898	PPL	0.143	3.47E-03
ENSG00000105514	RAB3D	0.143	4.84E-02
ENSG00000123975	CKS2	0.143	1.34E-02
ENSG00000101639	CEP192	0.143	1.54E-02
ENSG00000107290	SETX	0.143	1.90E-03
ENSG00000132964	CDK8	0.143	3.96E-02
ENSG00000158615	PPP1R15B	0.142	1.74E-03
ENSG00000184939	ZFP90	0.142	4.79E-02
ENSG00000163171	CDC42EP3	0.142	5.92E-03
ENSG00000196584	XRCC2	0.142	4.71E-02
ENSG00000067369	TP53BP1	0.142	1.54E-02
ENSG00000134762	DSC3	0.141	8.53E-04
ENSG00000127914	AKAP9	0.141	1.61E-02
ENSG00000131473	ACLY	0.141	4.98E-04
ENSG00000088808	PPP1R13B	0.141	4.88E-02
ENSG00000135968	GCC2	0.140	2.97E-02
ENSG00000197579	TOPORS	0.140	5.53E-03
ENSG00000100242	SUN2	0.140	1.29E-02
ENSG00000197948	FCHSD1	0.140	4.57E-02
ENSG00000163848	ZNF148	0.140	1.03E-02
ENSG00000266028	SRGAP2	0.140	1.63E-02
ENSG00000070961	ATP2B1	0.140	1.62E-02
ENSG00000100526	CDKN3	0.140	4.31E-02
ENSG00000159592	GPBP1L1	0.140	5.28E-03
ENSG00000166881	NEMP1	0.140	1.58E-02
ENSG00000117139	KDM5B	0.139	3.99E-03
ENSG00000243156	MICAL3	0.139	1.61E-02
ENSG00000196586	MYO6	0.139	2.32E-02
ENSG00000137804	NUSAP1	0.139	8.76E-04
ENSG00000165392	WRN	0.139	4.75E-02
ENSG00000277443	MARCKS	0.139	3.03E-03
ENSG00000167522	ANKRD11	0.138	4.53E-04
ENSG00000197299	BLM	0.138	3.87E-02
ENSG00000211455	STK38L	0.138	1.04E-02
ENSG00000092621	PHGDH	0.138	2.14E-02
ENSG00000175215	CTDSP2	0.138	4.07E-03
ENSG00000204842	ATXN2	0.138	1.12E-02
ENSG00000134058	CDK7	0.137	1.89E-02
ENSG00000128731	HERC2	0.137	1.67E-02
ENSG00000106346	USP42	0.137	3.16E-02

ENSG00000132471	WBP2	0.137	4.35E-02
ENSG00000171681	ATF7IP	0.137	6.93E-03
ENSG00000166444	ST5	0.137	3.53E-02
ENSG00000131263	RLIM	0.137	4.96E-03
ENSG00000048405	ZNF800	0.136	2.13E-02
ENSG00000051382	PIK3CB	0.136	5.04E-02
ENSG00000174106	LEMD3	0.135	2.59E-02
ENSG00000130158	DOCK6	0.135	4.51E-02
ENSG00000144283	PKP4	0.135	3.34E-03
ENSG00000120733	KDM3B	0.135	3.43E-03
ENSG00000153317	ASAP1	0.134	2.98E-03
ENSG00000067955	CBFB	0.134	2.41E-02
ENSG00000136560	TANK	0.134	2.81E-02
ENSG00000147548	WHSC1L1	0.134	4.21E-03
ENSG00000164823	OSGIN2	0.134	4.60E-02
ENSG00000109445	ZNF330	0.134	3.44E-02
ENSG00000145349	CAMK2D	0.134	3.89E-02
ENSG00000197183	NOL4L	0.134	1.57E-02
ENSG00000214944	ARHGEF28	0.134	3.21E-02
ENSG00000096070	BRPF3	0.134	2.66E-02
ENSG00000154640	BTG3	0.134	3.94E-02
ENSG00000068796	KIF2A	0.133	5.53E-03
ENSG00000162928	PEX13	0.133	3.57E-02
ENSG00000198786	MT-ND5	0.133	1.54E-02
ENSG00000204516	MICB	0.133	4.43E-02
ENSG00000114374	USP9Y	0.133	4.12E-02
ENSG00000198824	CHAMP1	0.133	1.36E-02
ENSG00000155329	ZCCHC10	0.133	4.28E-02
ENSG00000063978	RNF4	0.132	5.07E-03
ENSG00000125826	RBCK1	0.132	1.18E-02
ENSG00000163960	UBXN7	0.132	6.93E-03
ENSG00000114933	INO80D	0.132	4.19E-02
ENSG00000171316	CHD7	0.132	3.85E-02
ENSG00000120549	KIAA1217	0.132	3.34E-03
ENSG00000012048	BRCA1	0.131	6.60E-03
ENSG00000175216	CKAP5	0.131	1.41E-03
ENSG00000111011	RSRC2	0.131	5.76E-03
ENSG00000120063	GNA13	0.130	2.66E-02
ENSG00000145780	FEM1C	0.129	4.12E-02
ENSG00000023287	RB1CC1	0.129	3.64E-02
ENSG00000135679	MDM2	0.128	2.92E-02
ENSG00000115902	SLC1A4	0.128	4.29E-02
ENSG00000051620	HEBP2	0.128	1.51E-02

ENSG00000110274	CEP164	0.128	2.06E-02
ENSG00000140262	TCF12	0.128	2.01E-02
ENSG00000141664	ZCCHC2	0.128	3.67E-02
ENSG00000160741	CRTC2	0.128	3.85E-02
ENSG00000198886	MT-ND4	0.127	1.76E-02
ENSG00000006704	GTF2IRD1	0.127	3.49E-02
ENSG00000115183	TANC1	0.127	9.27E-03
ENSG00000181555	SETD2	0.127	3.45E-03
ENSG00000061936	SFSWAP	0.127	1.00E-02
ENSG00000173542	MOB1B	0.126	3.79E-02
ENSG00000165671	NSD1	0.126	3.60E-03
ENSG00000140464	PML	0.126	3.55E-02
ENSG00000062598	ELMO2	0.125	3.43E-02
ENSG00000101773	RBBP8	0.125	3.43E-03
ENSG00000184009	ACTG1	0.125	1.62E-03
ENSG00000117399	CDC20	0.125	8.13E-03
ENSG00000149657	LSM14B	0.125	2.22E-02
ENSG00000160007	ARHGAP35	0.125	2.17E-02
ENSG00000173889	PHC3	0.124	2.31E-02
ENSG00000168209	DDIT4	0.124	2.04E-03
ENSG00000115504	EHBP1	0.124	5.53E-03
ENSG00000170540	ARL6IP1	0.124	5.03E-02
ENSG00000033030	ZCCHC8	0.123	3.26E-02
ENSG00000109689	STIM2	0.123	2.89E-02
ENSG00000074356	NCBP3	0.123	2.90E-02
ENSG00000172466	ZNF24	0.123	1.80E-02
ENSG00000143442	POGZ	0.122	1.84E-02
ENSG00000065911	MTHFD2	0.122	1.17E-02
ENSG00000173821	RNF213	0.121	1.96E-02
ENSG00000070444	MNT	0.121	3.91E-02
ENSG00000171792	RHNO1	0.121	3.64E-02
ENSG00000053770	AP5M1	0.121	4.71E-02
ENSG00000106105	GARS	0.121	5.23E-03
ENSG00000146457	WTAP	0.121	1.61E-02
ENSG00000156671	SAMD8	0.120	3.03E-02
ENSG00000197969	VPS13A	0.120	4.73E-02
ENSG00000114346	ECT2	0.120	3.65E-02
ENSG00000009413	REV3L	0.120	4.12E-02
ENSG00000049618	ARID1B	0.120	2.41E-02
ENSG00000178913	TAF7	0.119	3.90E-02
ENSG00000066933	MYO9A	0.119	2.69E-02
ENSG00000112701	SENP6	0.119	5.02E-02
ENSG00000006453	BAIAP2L1	0.119	1.24E-02

ENSG00000124177	CHD6	0.118	1.96E-02
ENSG00000173230	GOLGB1	0.118	1.65E-02
ENSG00000075643	MOCOS	0.118	3.45E-02
ENSG00000197555	SIPA1L1	0.117	8.07E-03
ENSG00000102921	N4BP1	0.117	2.67E-02
ENSG00000060749	QSER1	0.117	1.78E-02
ENSG00000133789	SWAP70	0.116	3.77E-02
ENSG00000137575	SDCBP	0.116	2.87E-02
ENSG00000159128	IFNGR2	0.115	2.29E-02
ENSG00000147862	NFIB	0.115	1.42E-02
ENSG00000127870	RNF6	0.115	1.47E-02
ENSG00000119321	FKBP15	0.115	2.84E-02
ENSG00000137275	RIPK1	0.114	3.77E-02
ENSG00000095787	WAC	0.114	3.86E-03
ENSG00000173442	EHBP1L1	0.114	1.87E-02
ENSG00000054654	SYNE2	0.113	3.62E-02
ENSG00000108091	CCDC6	0.112	4.98E-02
ENSG00000011243	AKAP8L	0.112	3.77E-02
ENSG00000159840	ZYX	0.112	1.98E-02
ENSG00000036549	ZZZ3	0.112	2.14E-02
ENSG00000103111	MON1B	0.111	4.09E-02
ENSG00000137337	MDC1	0.111	1.61E-02
ENSG00000185591	SP1	0.111	1.32E-02
ENSG00000171988	JMJD1C	0.111	5.01E-02
ENSG00000198420	TCAF1	0.111	3.66E-02
ENSG00000120137	PANK3	0.110	4.12E-02
ENSG00000160785	SLC25A44	0.109	4.71E-02
ENSG00000168488	ATXN2L	0.109	3.96E-02
ENSG00000140941	MAP1LC3B	0.109	2.68E-02
ENSG00000169710	FASN	0.109	4.47E-02
ENSG00000172432	GTPBP2	0.108	4.16E-02
ENSG00000132424	PNISR	0.107	3.96E-02
ENSG00000164754	RAD21	0.107	2.73E-02
ENSG00000111676	ATN1	0.107	3.30E-02
ENSG00000198840	MT-ND3	0.107	2.67E-03
ENSG00000104756	KCTD9	0.106	3.24E-02
ENSG00000139990	DCAF5	0.106	2.66E-02
ENSG00000163872	YEATS2	0.106	4.08E-02
ENSG00000165006	UBAP1	0.106	2.97E-02
ENSG00000129636	ITFG1	0.106	4.34E-02
ENSG00000113360	DROSHA	0.106	1.09E-02
ENSG00000144566	RAB5A	0.104	4.28E-02
ENSG00000165219	GAPVD1	0.104	2.56E-02

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ENSG00000132002	DNAJB1	0.103	4.18E-02
ENSG00000116539	ASH1L	0.103	3.09E-02
ENSG00000138771	SHROOM3	0.102	4.98E-02
ENSG00000088038	CNOT3	0.102	4.18E-02
ENSG00000189266	PNRC2	0.102	2.90E-02
ENSG00000090061	CCNK	0.101	3.11E-02
ENSG00000116754	SRSF11	0.101	2.15E-02
ENSG00000123200	ZC3H13	0.101	2.30E-02
ENSG00000198815	FOXJ3	0.100	4.35E-02
ENSG00000124181	PLCG1	0.099	2.49E-02
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ENSG00000120802	TMPO	0.099	4.86E-02
ENSG00000168575	SLC20A2	0.098	4.18E-02
ENSG00000100650	SRSF5	0.097	2.75E-02
ENSG00000152795	HNRNPDL	0.097	1.88E-02
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ENSG00000158769	F11R	0.097	4.84E-02
ENSG00000118482	PHF3	0.097	4.72E-02
ENSG00000198727	MT-CYB	0.096	4.19E-02
ENSG00000151914	DST	0.096	1.08E-02
ENSG00000169641	LUZP1	0.094	3.39E-02
ENSG00000165304	MELK	0.094	3.55E-02
ENSG00000146670	CDCA5	0.094	3.62E-02
ENSG00000100207	TCF20	0.094	4.09E-02
ENSG00000127947	PTPN12	0.093	4.60E-02
ENSG00000163946	FAM208A	0.093	4.46E-02
ENSG00000115464	USP34	0.093	4.86E-02
ENSG00000166986	MARS	0.092	3.74E-02
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ENSG00000111206	FOXM1	0.090	3.54E-02
ENSG00000171456	ASXL1	0.089	3.15E-02
ENSG00000104549	SQLE	0.089	4.39E-02
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ENSG00000071127	WDR1	0.084	4.62E-02
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ENSG00000100316	RPL3	-0.075	3.77E-02
ENSG00000065978	YBX1	-0.075	3.03E-02
ENSG00000174444	RPL4	-0.077	2.52E-02
ENSG00000145425	RPS3A	-0.078	4.96E-02
ENSG00000122026	RPL21	-0.078	4.84E-02

ENSG00000113013	HSPA9	-0.079	4.93E-02
ENSG00000170606	HSPA4	-0.079	4.38E-02
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ENSG00000161016	RPL8	-0.081	3.67E-02
ENSG00000065427	KARS	-0.081	4.34E-02
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ENSG00000111640	GAPDH	-0.082	2.89E-02
ENSG00000125944	HNRNPR	-0.082	4.34E-02
ENSG00000113719	ERGIC1	-0.082	4.00E-02
ENSG00000111669	TPI1	-0.082	4.01E-02
ENSG00000132341	RAN	-0.083	4.61E-02
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ENSG00000144713	RPL32	-0.084	4.17E-02
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ENSG00000189403	HMGB1	-0.085	3.19E-02
ENSG00000197958	RPL12	-0.085	2.37E-02
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ENSG00000147955	SIGMAR1	-0.087	4.59E-02
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ENSG00000104738	MCM4	-0.093	2.00E-02

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ENSG00000197746	PSAP	-0.094	2.01E-02
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ENSG00000073578	SDHA	-0.095	2.46E-02
ENSG00000186081	KRT5	-0.095	3.34E-03
ENSG00000124789	NUP153	-0.095	2.55E-02
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ENSG00000164733	CTSB	-0.096	1.75E-02
ENSG00000173706	HEG1	-0.096	4.62E-02
ENSG00000104331	IMPAD1	-0.096	3.95E-02
ENSG00000170017	ALCAM	-0.096	2.89E-02
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ENSG00000081277	PKP1	-0.097	2.57E-02
ENSG00000183853	KIRREL	-0.097	2.69E-02
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ENSG00000166250	CLMP	-0.097	2.16E-02
ENSG00000148175	STOM	-0.097	1.16E-02
ENSG00000130726	TRIM28	-0.097	4.02E-02
ENSG00000197451	HNRNPAB	-0.097	1.05E-02
ENSG00000164924	YWHAZ	-0.097	1.91E-02
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ENSG00000089157	RPLP0	-0.098	1.08E-02
ENSG00000087269	NOP14	-0.098	4.60E-02
ENSG00000182934	SRPR	-0.098	2.81E-02
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ENSG00000198053	SIRPA	-0.099	3.20E-02
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ENSG00000134697	GNL2	-0.099	3.18E-02
ENSG00000145391	SETD7	-0.100	3.30E-02
ENSG00000087263	OGFOD1	-0.100	3.79E-02
ENSG00000100216	TOMM22	-0.100	3.85E-02
ENSG00000147403	RPL10	-0.101	1.53E-02
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ENSG00000108829	LRRC59	-0.101	1.20E-02
ENSG00000163468	CCT3	-0.101	1.04E-02
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ENSG00000119655	NPC2	-0.103	3.85E-02
ENSG00000115307	AUP1	-0.103	4.28E-02
ENSG00000113140	SPARC	-0.103	1.74E-02
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ENSG00000065618	COL17A1	-0.104	1.07E-02
ENSG00000174437	ATP2A2	-0.104	2.98E-03
ENSG00000105976	MET	-0.104	8.49E-03
ENSG00000168090	COPS6	-0.104	3.94E-02
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ENSG00000003056	M6PR	-0.104	2.07E-02
ENSG00000143641	GALNT2	-0.104	3.15E-02
ENSG00000037474	NSUN2	-0.105	1.17E-02
ENSG00000130811	EIF3G	-0.105	2.59E-02
ENSG00000135862	LAMC1	-0.105	4.67E-03
ENSG00000103335	PIEZO1	-0.106	3.71E-02
ENSG00000145685	LHFPL2	-0.106	3.86E-02
ENSG00000076706	MCAM	-0.106	1.03E-02
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ENSG00000128641	MYO1B	-0.107	5.56E-03
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ENSG00000135956	TMEM127	-0.108	4.95E-02
ENSG00000124783	SSR1	-0.108	4.12E-02
ENSG00000106367	AP1S1	-0.108	4.18E-02
ENSG00000173113	TRMT112	-0.108	3.75E-02
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ENSG00000141522	ARHGDIA	-0.109	2.04E-02
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ENSG00000184216	IRAK1	-0.110	2.65E-02
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ENSG00000029153	ARNTL2	-0.110	3.66E-02
ENSG00000125834	STK35	-0.110	4.51E-02
ENSG00000025800	KPNA6	-0.111	2.02E-02
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ENSG00000033050	ABCF2	-0.112	1.59E-02
ENSG00000114942	EEF1B2	-0.112	7.06E-03
ENSG00000125827	TMX4	-0.112	3.53E-02
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ENSG00000168924	LETM1	-0.113	2.35E-02
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ENSG00000275832	ARHGAP23	-0.113	1.88E-02
ENSG00000147533	GOLGA7	-0.113	3.80E-02
ENSG00000079332	SAR1A	-0.113	1.34E-02
ENSG00000170515	PA2G4	-0.114	3.15E-03
ENSG00000001497	LAS1L	-0.114	2.39E-02
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ENSG00000077549	CAPZB	-0.114	3.54E-02
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ENSG00000065526	SPEN	-0.115	9.04E-03
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ENSG00000092820	EZR	-0.115	2.39E-03
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ENSG00000160818	GPATCH4	-0.115	1.96E-02
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ENSG00000104131	EIF3J	-0.118	8.72E-03
ENSG00000120800	UTP20	-0.118	3.52E-02
ENSG00000124535	WRNIP1	-0.118	1.86E-02
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ENSG00000124172	ATP5E	-0.118	1.48E-02
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ENSG00000115053	NCL	-0.119	1.06E-03
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ENSG00000102978	POLR2C	-0.119	3.46E-02
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ENSG00000145220	LYAR	-0.119	2.90E-02
ENSG00000147394	ZNF185	-0.120	1.54E-02
ENSG00000125870	SNRPB2	-0.120	1.88E-02
ENSG00000166025	AMOTL1	-0.120	1.89E-03
ENSG00000100462	PRMT5	-0.120	3.18E-03
ENSG00000163811	WDR43	-0.121	1.07E-02
ENSG00000106484	MEST	-0.121	1.82E-02
ENSG00000114353	GNAI2	-0.122	1.68E-02
ENSG00000182307	C8orf33	-0.122	4.73E-02
ENSG00000118640	VAMP8	-0.122	4.49E-02
ENSG00000143486	EIF2D	-0.122	2.20E-02
ENSG00000145907	G3BP1	-0.122	3.69E-03
ENSG00000140564	FURIN	-0.122	3.54E-02
ENSG00000078808	SDF4	-0.122	3.59E-02
ENSG00000158710	TAGLN2	-0.122	3.85E-03
ENSG00000168092	PAFAH1B2	-0.122	1.24E-02
ENSG00000148229	POLE3	-0.122	3.51E-03
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ENSG00000114993	RTKN	-0.125	2.38E-02
ENSG00000161547	SRSF2	-0.125	1.24E-02
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ENSG00000159199	ATP5G1	-0.127	2.04E-02
ENSG00000102172	SMS	-0.127	2.89E-03
ENSG00000196756	SNHG17	-0.128	4.08E-02
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ENSG00000132604	TERF2	-0.129	3.49E-02
ENSG00000170027	YWHAG	-0.129	2.01E-03
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ENSG00000146535	GNA12	-0.130	2.18E-02
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ENSG00000165283	STOML2	-0.131	2.69E-02
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ENSG00000144824	PHLDB2	-0.132	1.06E-02
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ENSG00000104979	C19orf53	-0.156	1.19E-02
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ENSG00000124782	RREB1	-0.158	5.15E-03
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ENSG00000136875	PRPF4	-0.170	4.18E-04
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ENSG00000139620	KANSL2	-0.176	1.91E-02
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ENSG00000167378	IRGQ	-0.180	2.34E-02
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ENSG00000105974	CAV1	-0.181	3.86E-05
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ENSG00000227036	LINC00511	-0.183	2.01E-02
ENSG00000109133	TMEM33	-0.183	3.16E-03
ENSG00000126822	PLEKHG3	-0.183	1.31E-04
ENSG00000171992	SYNPO	-0.184	8.98E-04
ENSG00000137962	ARHGAP29	-0.184	2.37E-03
ENSG00000137203	TFAP2A	-0.184	9.47E-04

ENSG00000114850	SSR3	-0.185	1.71E-04
ENSG00000180992	MRPL14	-0.185	1.99E-02
ENSG00000114554	PLXNA1	-0.186	5.62E-04
ENSG00000134247	PTGFRN	-0.186	2.37E-05
ENSG00000128059	PPAT	-0.186	1.73E-02
ENSG00000133639	BTG1	-0.187	5.64E-03
ENSG00000277161	PIGW	-0.187	1.05E-02
ENSG00000140859	KIFC3	-0.187	2.18E-02
ENSG00000169047	IRS1	-0.187	4.75E-04
ENSG00000168398	BDKRB2	-0.187	4.21E-02
ENSG00000100558	PLEK2	-0.188	1.38E-03
ENSG00000176022	B3GALT6	-0.188	5.30E-03
ENSG00000196396	PTPN1	-0.189	5.95E-06
ENSG00000104356	POP1	-0.190	6.60E-03
ENSG00000186603	HPDL	-0.190	5.01E-02
ENSG00000107815	C10orf2	-0.190	1.82E-03
ENSG00000164171	ITGA2	-0.190	2.56E-04
ENSG00000082516	GEMIN5	-0.190	3.36E-04
ENSG00000132768	DPH2	-0.191	3.97E-03
ENSG00000214114	MYCBP	-0.191	1.20E-02
ENSG00000110104	CCDC86	-0.191	2.77E-04
ENSG00000197461	PDGFA	-0.191	8.16E-03
ENSG00000138074	SLC5A6	-0.191	1.30E-02
ENSG00000131435	PDLIM4	-0.192	8.18E-03
ENSG00000121671	CRY2	-0.192	4.07E-02
ENSG00000137054	POLR1E	-0.193	8.71E-03
ENSG00000196639	HRH1	-0.193	3.34E-03
ENSG00000107404	DVL1	-0.193	8.75E-04
ENSG00000004660	CAMKK1	-0.194	4.49E-02
ENSG00000124787	RPP40	-0.194	3.72E-02
ENSG00000240972	MIF	-0.194	2.92E-03
ENSG00000017483	SLC38A5	-0.194	7.94E-03
ENSG00000123505	AMD1	-0.194	9.12E-05
ENSG00000099337	KCNK6	-0.194	1.50E-03
ENSG00000111335	OAS2	-0.194	3.28E-02
ENSG00000095383	TBC1D2	-0.195	7.02E-04
ENSG00000112759	SLC29A1	-0.195	1.81E-04
ENSG00000188643	S100A16	-0.196	1.88E-05
ENSG00000143179	UCK2	-0.197	2.39E-04
ENSG00000158292	GPR153	-0.197	3.14E-02
ENSG00000148331	ASB6	-0.197	6.42E-03
ENSG00000122490	PQLC1	-0.197	1.66E-02
ENSG00000102471	NDFIP2	-0.197	1.46E-03

ENSG00000153006	SREK1IP1	-0.197	2.85E-03
ENSG00000163577	EIF5A2	-0.198	4.10E-02
ENSG00000147164	SNX12	-0.198	8.76E-04
ENSG00000172590	MRPL52	-0.199	3.80E-03
ENSG00000163597	SNHG16	-0.199	4.21E-04
ENSG00000109320	NFKB1	-0.199	1.43E-05
ENSG00000007376	RPUSD1	-0.200	8.78E-03
ENSG00000151693	ASAP2	-0.200	1.85E-05
ENSG00000182022	CHST15	-0.201	4.99E-04
ENSG00000020577	SAMD4A	-0.201	3.99E-04
ENSG00000161091	MFSD12	-0.202	2.34E-03
ENSG00000185507	IRF7	-0.202	3.92E-02
ENSG00000185963	BICD2	-0.202	1.76E-05
ENSG00000185070	FLRT2	-0.202	7.90E-04
ENSG00000104267	CA2	-0.203	4.07E-02
ENSG00000174840	PDE12	-0.203	6.38E-04
ENSG00000140650	PMM2	-0.203	3.35E-03
ENSG00000053372	MRTO4	-0.203	4.86E-04
ENSG00000175305	CCNE2	-0.204	1.41E-02
ENSG00000095951	HIVEP1	-0.204	1.23E-04
ENSG00000171763	SPATA5L1	-0.205	2.42E-02
ENSG00000069869	NEDD4	-0.205	1.81E-04
ENSG00000065802	ASB1	-0.206	1.02E-04
ENSG00000187498	COL4A1	-0.206	1.61E-03
ENSG00000137936	BCAR3	-0.206	2.60E-05
ENSG00000161544	CYGB	-0.206	7.53E-03
ENSG00000253368	TRNP1	-0.206	6.92E-03
ENSG00000105875	WDR91	-0.207	8.72E-03
ENSG00000197037	ZSCAN25	-0.207	1.15E-02
ENSG00000165724	ZMYND19	-0.208	1.52E-03
ENSG00000135074	ADAM19	-0.208	3.49E-02
ENSG00000185219	ZNF445	-0.209	1.08E-02
ENSG00000213064	SFT2D2	-0.209	3.13E-03
ENSG00000023445	BIRC3	-0.209	3.91E-03
ENSG00000086062	B4GALT1	-0.209	2.82E-06
ENSG00000122641	INHBA	-0.210	2.58E-03
ENSG00000183421	RIPK4	-0.210	3.64E-03
ENSG00000184602	SNN	-0.210	6.58E-03
ENSG00000087303	NID2	-0.210	4.32E-03
ENSG00000126803	HSPA2	-0.210	8.32E-04
ENSG00000183337	BCOR	-0.211	5.90E-04
ENSG00000204160	ZDHHC18	-0.211	4.01E-03
ENSG00000225663	FAM195B	-0.212	4.96E-02

ENSG00000100647	SUSD6	-0.212	1.69E-04
ENSG00000125731	SH2D3A	-0.212	5.87E-04
ENSG00000108854	SMURF2	-0.213	2.65E-04
ENSG00000101624	CEP76	-0.213	2.78E-02
ENSG00000236552	RPL13AP5	-0.213	2.39E-02
ENSG00000109861	CTSC	-0.214	7.02E-06
ENSG00000109971	HSPA8	-0.214	2.42E-07
ENSG00000177352	CCDC71	-0.214	3.49E-02
ENSG00000166452	AKIP1	-0.215	2.66E-02
ENSG00000265190	ANXA8	-0.215	1.11E-06
ENSG00000177971	IMP3	-0.215	1.19E-03
ENSG00000165271	NOL6	-0.215	3.02E-05
ENSG00000127824	TUBA4A	-0.216	4.15E-05
ENSG00000136379	ABHD17C	-0.216	8.77E-03
ENSG00000198890	PRMT6	-0.216	3.36E-03
ENSG00000225830	ERCC6	-0.217	6.69E-03
ENSG00000162545	CAMK2N1	-0.217	4.41E-04
ENSG00000106665	CLIP2	-0.217	4.17E-03
ENSG00000168792	ABHD15	-0.217	2.92E-02
ENSG00000160209	PDXK	-0.218	3.27E-05
ENSG00000174791	RIN1	-0.218	4.58E-04
ENSG00000101347	SAMHD1	-0.219	3.62E-05
ENSG00000087245	MMP2	-0.219	1.70E-02
ENSG00000010818	HIVEP2	-0.220	4.81E-06
ENSG00000160208	RRP1B	-0.221	9.34E-05
ENSG00000115289	PCGF1	-0.221	3.84E-02
ENSG00000204946	ZNF783	-0.221	1.90E-03
ENSG00000135318	NT5E	-0.221	9.42E-06
ENSG00000158470	B4GALT5	-0.221	1.72E-05
ENSG00000236144	TMEM147-AS1	-0.221	1.96E-02
ENSG00000116649	SRM	-0.221	9.99E-05
ENSG00000185085	INTS5	-0.221	7.69E-03
ENSG00000112245	PTP4A1	-0.222	7.30E-05
ENSG00000166860	ZBTB39	-0.222	1.12E-02
ENSG00000115594	IL1R1	-0.223	4.66E-03
ENSG00000131845	ZNF304	-0.224	2.59E-02
ENSG00000170561	IRX2	-0.224	3.00E-04
ENSG00000196083	IL1RAP	-0.224	7.64E-05
ENSG00000179409	GEMIN4	-0.224	1.68E-04
ENSG00000117122	MFAP2	-0.225	4.03E-02
ENSG00000118985	ELL2	-0.225	1.95E-06
ENSG00000166949	SMAD3	-0.225	8.90E-06

ENSG00000240563	L1TD1	-0.226	3.70E-02
ENSG00000100065	CARD10	-0.226	5.10E-04
ENSG00000180530	NRIP1	-0.227	9.18E-05
ENSG00000180694	TMEM64	-0.228	2.30E-02
ENSG00000162972	C2orf47	-0.228	4.62E-02
ENSG00000213923	CSNK1E	-0.229	3.35E-06
ENSG00000142188	TMEM50B	-0.230	2.97E-02
ENSG00000255717	SNHG1	-0.231	1.22E-04
ENSG00000070614	NDST1	-0.232	2.22E-05
ENSG00000196204	RNF216P1	-0.232	2.21E-02
ENSG00000160072	ATAD3B	-0.233	1.41E-03
ENSG00000136603	SKIL	-0.233	5.17E-04
ENSG00000223496	EXOSC6	-0.233	4.54E-04
ENSG00000117143	UAP1	-0.234	3.22E-05
ENSG00000091409	ITGA6	-0.235	2.22E-07
ENSG00000152413	HOMER1	-0.235	1.48E-03
ENSG00000178922	HYI	-0.235	2.96E-03
ENSG00000139926	FRMD6	-0.236	5.40E-06
ENSG00000141448	GATA6	-0.236	3.36E-03
ENSG00000125148	MT2A	-0.237	3.64E-03
ENSG00000106852	LHX6	-0.238	4.27E-03
ENSG00000146828	SLC12A9	-0.238	1.39E-02
ENSG00000164251	F2RL1	-0.238	4.13E-04
ENSG00000075426	FOSL2	-0.238	3.92E-07
ENSG00000112578	BYSL	-0.239	8.89E-04
ENSG00000198042	MAK16	-0.240	3.49E-04
ENSG00000048162	NOP16	-0.240	2.25E-05
ENSG00000130147	SH3BP4	-0.240	2.79E-06
ENSG00000138685	FGF2	-0.241	8.00E-04
ENSG00000150630	VEGFC	-0.241	3.12E-03
ENSG00000165799	RNASE7	-0.242	3.41E-02
ENSG00000176170	SPHK1	-0.242	2.28E-04
ENSG00000115884	SDC1	-0.242	3.02E-07
ENSG00000120913	PDLIM2	-0.242	1.19E-02
ENSG00000125630	POLR1B	-0.243	4.92E-04
ENSG00000143153	ATP1B1	-0.243	1.34E-05
ENSG00000179163	FUCA1	-0.244	4.71E-03
ENSG00000057019	DCBLD2	-0.245	3.51E-05
ENSG00000154127	UBASH3B	-0.245	2.30E-04
ENSG00000174165	ZDHHC24	-0.246	2.81E-02
ENSG00000178896	EXOSC4	-0.247	3.60E-03
ENSG00000113645	WWC1	-0.247	6.65E-06
ENSG00000142627	EPHA2	-0.248	7.02E-06

ENSG00000198455	ZXDB	-0.248	1.77E-03
ENSG00000176641	RNF152	-0.248	3.49E-02
ENSG00000135111	TBX3	-0.249	4.61E-02
ENSG00000053747	LAMA3	-0.249	5.87E-06
ENSG00000103064	SLC7A6	-0.249	1.84E-05
ENSG00000100285	NEFH	-0.249	1.03E-05
ENSG00000198959	TGM2	-0.250	1.81E-04
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ENSG00000214357	NEURL1B	-0.250	4.92E-04
ENSG00000147509	RGS20	-0.250	4.31E-02
ENSG00000112033	PPARD	-0.251	4.21E-05
ENSG00000111859	NEDD9	-0.252	4.65E-03
ENSG00000119714	GPR68	-0.252	4.67E-03
ENSG00000256235	SMIM3	-0.252	2.01E-02
ENSG00000178695	KCTD12	-0.252	2.14E-06
ENSG00000176597	B3GNT5	-0.253	1.66E-05
ENSG00000189410	SH2D5	-0.253	8.58E-04
ENSG00000184110	EIF3C	-0.254	3.33E-03
ENSG00000206075	SERPINB5	-0.254	1.08E-06
ENSG00000108342	CSF3	-0.254	6.14E-04
ENSG00000165655	ZNF503	-0.255	6.45E-04
ENSG00000136869	TLR4	-0.255	2.41E-03
ENSG00000177508	IRX3	-0.256	6.31E-03
ENSG00000101384	JAG1	-0.256	1.60E-06
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ENSG00000148344	PTGES	-0.258	4.41E-04
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ENSG00000168806	LCMT2	-0.258	8.18E-04
ENSG00000165905	GYLTL1B	-0.260	9.72E-05
ENSG00000179886	TIGD5	-0.260	4.88E-02
ENSG00000165312	OTUD1	-0.260	4.73E-02
ENSG00000196227	FAM217B	-0.261	6.48E-04
ENSG00000027869	SH2D2A	-0.261	1.34E-03
ENSG00000124145	SDC4	-0.261	1.56E-07
ENSG00000125459	MSTO1	-0.262	7.77E-03
ENSG00000128591	FLNC	-0.263	7.32E-04
ENSG00000157240	FZD1	-0.263	2.32E-02
ENSG00000117479	SLC19A2	-0.263	6.42E-03
ENSG00000115756	HPCAL1	-0.263	6.51E-04
ENSG00000264230	ANXA8L1	-0.264	2.10E-06
ENSG00000132669	RIN2	-0.265	1.54E-05
ENSG00000164465	DCBLD1	-0.266	8.08E-06

ENSG00000163251	FZD5	-0.267	2.21E-02
ENSG00000120942	UBIAD1	-0.267	1.16E-04
ENSG00000075223	SEMA3C	-0.267	1.38E-05
ENSG00000169020	ATP5I	-0.268	1.47E-03
ENSG00000104450	SPAG1	-0.271	7.60E-04
ENSG00000127418	FGFRL1	-0.271	3.71E-06
ENSG00000153094	BCL2L11	-0.272	6.59E-03
ENSG00000188636	LDOC1L	-0.272	3.63E-05
ENSG00000107738	C10orf54	-0.273	1.82E-02
ENSG00000105825	TFPI2	-0.273	3.62E-05
ENSG00000127334	DYRK2	-0.274	1.69E-04
ENSG00000175573	C11orf68	-0.274	1.89E-03
ENSG00000164161	HHIP	-0.275	2.47E-03
ENSG00000162650	ATXN7L2	-0.275	6.67E-03
ENSG00000265972	TXNIP	-0.276	2.26E-05
ENSG00000184182	UBE2F	-0.276	3.26E-02
ENSG00000178718	RPP25	-0.276	5.62E-05
ENSG00000103257	SLC7A5	-0.277	3.97E-08
ENSG00000269378	ITGB1P1	-0.277	4.25E-02
ENSG00000162493	PDPN	-0.278	2.21E-05
ENSG00000145632	PLK2	-0.280	2.33E-04
ENSG00000155850	SLC26A2	-0.282	4.17E-07
ENSG00000213412	HNRNPA1P33	-0.283	1.52E-04
ENSG00000204103	MAFB	-0.286	4.61E-02
ENSG00000166189	HPS6	-0.288	3.00E-04
ENSG00000185504	FAAP100	-0.289	1.17E-04
ENSG00000003137	CYP26B1	-0.289	1.86E-02
ENSG00000168101	NUDT16L1	-0.290	3.50E-02
ENSG00000101311	FERMT1	-0.290	1.06E-07
ENSG00000099860	GADD45B	-0.290	1.22E-03
ENSG00000137440	FGFBP1	-0.290	4.42E-08
ENSG00000163521	GLB1L	-0.291	2.33E-02
ENSG00000112365	ZBTB24	-0.292	8.84E-05
ENSG00000163513	TGFBR2	-0.292	8.05E-09
ENSG00000003989	SLC7A2	-0.293	9.38E-06
ENSG00000122696	SLC25A51	-0.294	2.49E-02
ENSG00000102312	PORCN	-0.294	2.14E-06
ENSG00000099812	MISP	-0.294	3.92E-05
ENSG00000212232	SNORD17	-0.294	2.38E-02
ENSG00000106799	TGFBR1	-0.295	1.83E-05
ENSG00000100292	HMOX1	-0.296	2.86E-02
ENSG00000158023	WDR66	-0.296	6.55E-06
ENSG00000176595	KBTBD11	-0.296	8.36E-03

ENSG00000128203	ASPHD2	-0.298	3.57E-02
ENSG00000167601	AXL	-0.299	9.93E-07
ENSG00000169515	CCDC8	-0.299	3.84E-03
ENSG00000169955	ZNF747	-0.301	2.51E-02
ENSG00000160712	IL6R	-0.302	1.36E-06
ENSG00000163155	LYSMD1	-0.303	2.63E-02
ENSG00000130449	ZSWIM6	-0.303	1.80E-06
ENSG00000129514	FOXA1	-0.304	3.01E-03
ENSG00000108733	PEX12	-0.304	2.13E-02
ENSG00000175866	BAIAP2	-0.306	3.49E-05
ENSG00000174136	RGMB	-0.307	7.77E-07
ENSG00000157933	SKI	-0.308	5.96E-07
ENSG00000114767	RRP9	-0.309	2.37E-05
ENSG00000172548	NIPAL4	-0.309	8.79E-08
ENSG00000129474	AJUBA	-0.309	3.88E-08
ENSG00000137218	FRS3	-0.311	4.35E-02
ENSG00000182795	C1orf116	-0.311	2.93E-09
ENSG00000124217	MOCS3	-0.311	1.23E-04
ENSG00000148841	ITPRIP	-0.312	3.84E-07
ENSG00000070404	FSTL3	-0.312	4.45E-06
ENSG00000184792	OSBP2	-0.313	7.49E-06
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ENSG00000278709	NKILA	-0.313	1.88E-02
ENSG00000184185	KCNJ12	-0.314	1.30E-02
ENSG00000178409	BEND3	-0.315	4.70E-04
ENSG00000137393	RNF144B	-0.315	2.60E-04
ENSG00000101665	SMAD7	-0.316	4.74E-04
ENSG00000142279	WTIP	-0.316	2.94E-03
ENSG00000137094	DNAJB5	-0.317	1.18E-07
ENSG00000180573	HIST1H2AC	-0.318	2.01E-02
ENSG00000108179	PPIF	-0.318	1.38E-08
ENSG00000178935	ZNF552	-0.320	3.42E-02
ENSG00000134461	ANKRD16	-0.320	4.59E-02
ENSG00000168264	IRF2BP2	-0.321	6.57E-09
ENSG00000224861	YBX1P1	-0.321	3.42E-03
ENSG00000173227	SYT12	-0.323	4.72E-03
ENSG00000232956	SNHG15	-0.324	1.23E-03
ENSG00000180611	MB21D2	-0.324	3.80E-02
ENSG00000137154	RPS6	-0.325	1.38E-03
ENSG00000088826	SMOX	-0.328	9.53E-06
ENSG00000188807	TMEM201	-0.329	8.98E-06
ENSG00000196352	CD55	-0.329	4.78E-08
ENSG00000171617	ENC1	-0.332	2.58E-05

ENSG00000198142	SOWAHC	-0.335	6.63E-08
ENSG00000188549	C15orf52	-0.336	1.45E-05
ENSG00000160886	LY6K	-0.337	1.61E-02
ENSG00000159216	RUNX1	-0.340	1.21E-07
ENSG00000088726	TMEM40	-0.341	6.36E-05
ENSG00000147689	FAM83A	-0.342	1.48E-07
ENSG00000107338	SHB	-0.342	1.49E-03
ENSG00000196502	SULT1A1	-0.343	2.51E-03
ENSG00000144120	TMEM177	-0.343	1.15E-03
ENSG00000101361	NOP56	-0.344	7.44E-10
ENSG00000260549	MT1L	-0.347	3.38E-05
ENSG00000138944	KIAA1644	-0.347	2.21E-04
ENSG00000275183	LENG9	-0.348	8.40E-03
ENSG00000179041	RRS1	-0.348	1.78E-06
ENSG00000160993	ALKBH4	-0.349	2.96E-03
ENSG00000087495	PHACTR3	-0.349	4.31E-03
ENSG00000139211	AMIGO2	-0.351	3.71E-06
ENSG00000175591	P2RY2	-0.355	1.91E-05
ENSG00000125430	HS3ST3B1	-0.356	9.78E-03
ENSG00000133816	MICAL2	-0.357	7.10E-10
ENSG00000117525	F3	-0.357	8.37E-10
ENSG00000131016	AKAP12	-0.358	4.68E-07
ENSG00000157168	NRG1	-0.358	5.56E-04
ENSG00000049759	NEDD4L	-0.358	3.65E-09
ENSG00000204519	ZNF551	-0.359	2.46E-03
ENSG00000198298	ZNF485	-0.359	3.90E-02
ENSG00000185730	ZNF696	-0.359	1.33E-02
ENSG00000118971	CCND2	-0.361	2.25E-07
ENSG00000132326	PER2	-0.362	1.93E-05
ENSG00000164086	DUSP7	-0.363	3.54E-10
ENSG00000112149	CD83	-0.364	4.54E-04
ENSG00000160207	HSF2BP	-0.364	7.53E-03
ENSG00000102804	TSC22D1	-0.365	3.54E-10
ENSG00000172216	CEBPB	-0.366	4.24E-07
ENSG00000168685	IL7R	-0.369	4.10E-03
ENSG00000115758	ODC1	-0.370	1.23E-10
ENSG00000185164	NOMO2	-0.372	1.28E-02
ENSG00000173281	PPP1R3B	-0.372	6.43E-04
ENSG00000114251	WNT5A	-0.373	3.04E-02
ENSG00000197375	SLC22A5	-0.373	1.45E-06
ENSG00000185186	LINC00313	-0.377	4.15E-02
ENSG00000181274	FRAT2	-0.378	4.26E-04
ENSG00000245848	CEBPA	-0.378	4.79E-02

ENSG00000170549	IRX1	-0.382	4.36E-04
ENSG00000115507	OTX1	-0.383	2.50E-04
ENSG00000268104	SLC6A14	-0.386	3.71E-02
ENSG00000125538	IL1B	-0.387	1.34E-08
ENSG00000148426	PROSER2	-0.388	2.22E-08
ENSG00000183876	ARSI	-0.388	2.86E-05
ENSG00000185614	FAM212A	-0.389	1.40E-02
ENSG00000171488	LRRC8C	-0.389	1.36E-06
ENSG00000241749	RPSAP52	-0.389	2.16E-02
ENSG00000186106	ANKRD46	-0.390	1.29E-02
ENSG00000110092	CCND1	-0.390	1.18E-11
ENSG00000249471	ZNF324B	-0.392	1.15E-02
ENSG00000034152	MAP2K3	-0.392	2.15E-08
ENSG00000234602	MCIDAS	-0.393	4.30E-02
ENSG00000135763	URB2	-0.395	1.40E-07
ENSG00000100036	SLC35E4	-0.396	8.98E-04
ENSG00000150457	LATS2	-0.397	4.93E-06
ENSG00000012171	SEMA3B	-0.398	7.06E-05
ENSG00000132825	PPP1R3D	-0.400	6.38E-04
ENSG00000139725	RHOF	-0.400	1.34E-07
ENSG00000120696	KBTBD7	-0.401	9.05E-04
ENSG00000090447	TFAP4	-0.404	1.88E-05
ENSG00000115266	APC2	-0.404	1.99E-04
ENSG00000163686	ABHD6	-0.405	3.59E-03
ENSG00000187837	HIST1H1C	-0.408	2.75E-02
ENSG00000275004	ZNF280B	-0.408	3.94E-02
ENSG00000163235	TGFA	-0.410	1.09E-10
ENSG00000175920	DOK7	-0.411	2.01E-02
ENSG00000176749	CDK5R1	-0.414	8.16E-03
ENSG00000153976	HS3ST3A1	-0.414	3.00E-04
ENSG00000110047	EHD1	-0.415	1.62E-09
ENSG00000156113	KCNMA1	-0.415	1.05E-03
ENSG00000115009	CCL20	-0.416	5.11E-05
ENSG00000196371	FUT4	-0.417	1.50E-04
ENSG00000186174	BCL9L	-0.418	4.46E-10
ENSG00000168906	MAT2A	-0.420	8.35E-11
ENSG00000143507	DUSP10	-0.421	7.07E-04
ENSG00000125968	ID1	-0.423	1.68E-06
ENSG00000125398	SOX9	-0.423	1.03E-06
ENSG00000186272	ZNF17	-0.427	8.11E-03
ENSG00000117877	CD3EAP	-0.430	7.10E-10
ENSG00000133121	STARD13	-0.430	2.74E-06
ENSG00000145860	RNF145	-0.434	8.61E-10

ENSG00000169851	PCDH7	-0.438	2.30E-04
ENSG00000174276	ZNHIT2	-0.441	3.06E-03
ENSG00000157551	KCNJ15	-0.442	2.42E-08
ENSG00000240891	PLCXD2	-0.445	4.20E-02
ENSG00000198841	KTI12	-0.445	8.17E-05
ENSG00000148154	UGCG	-0.445	3.71E-06
ENSG00000171056	SOX7	-0.446	5.45E-08
ENSG00000153395	LPCAT1	-0.446	1.23E-10
ENSG00000251493	FOXD1	-0.446	1.35E-03
ENSG00000169252	ADRB2	-0.448	5.88E-08
ENSG00000165572	KBTBD6	-0.451	3.93E-07
ENSG00000146555	SDK1	-0.451	2.63E-02
ENSG00000081041	CXCL2	-0.451	1.66E-07
ENSG00000171608	PIK3CD	-0.453	5.89E-07
ENSG00000179431	FJX1	-0.454	6.82E-06
ENSG00000188483	IER5L	-0.455	1.38E-05
ENSG00000169715	MT1E	-0.457	3.38E-10
ENSG00000114019	AMOTL2	-0.457	3.13E-08
ENSG00000143867	OSR1	-0.457	2.10E-02
ENSG00000242071	RPL7AP6	-0.457	4.06E-02
ENSG00000184678	HIST2H2BE	-0.464	1.82E-02
ENSG00000110987	BCL7A	-0.464	5.27E-08
ENSG00000054598	FOXC1	-0.464	1.65E-06
ENSG00000188167	TMPPE	-0.465	2.24E-02
ENSG00000184254	ALDH1A3	-0.469	1.13E-11
ENSG00000143816	WNT9A	-0.470	1.76E-05
ENSG00000123358	NR4A1	-0.474	1.84E-05
ENSG00000176692	FOXC2	-0.476	1.77E-08
ENSG00000238266	LINC00707	-0.477	3.06E-07
ENSG00000247844	CCAT1	-0.477	1.75E-02
ENSG00000198406	BZW1P2	-0.477	2.38E-02
ENSG00000128594	LRRC4	-0.477	5.15E-03
ENSG00000183114	FAM43B	-0.480	4.06E-02
ENSG00000254703	SENCR	-0.483	4.58E-03
ENSG00000253161	LINC01605	-0.485	3.81E-02
ENSG00000170684	ZNF296	-0.486	9.21E-05
ENSG00000182585	EPGN	-0.488	9.59E-05
ENSG00000083817	ZNF416	-0.489	2.24E-02
ENSG00000243444	PALM2	-0.490	4.44E-02
ENSG00000177311	ZBTB38	-0.491	9.59E-13
ENSG00000124766	SOX4	-0.491	3.38E-10
ENSG00000090776	EFNB1	-0.499	1.93E-11
ENSG00000138623	SEMA7A	-0.504	1.10E-07

ENSG00000126778	SIX1	-0.509	4.75E-07
ENSG00000196878	LAMB3	-0.513	1.28E-12
ENSG00000125845	BMP2	-0.515	4.00E-10
ENSG00000135312	HTR1B	-0.515	4.45E-02
ENSG00000131746	TNS4	-0.522	1.87E-13
ENSG00000020633	RUNX3	-0.522	5.03E-04
ENSG00000215012	C22orf29	-0.523	1.10E-08
ENSG00000134954	ETS1	-0.529	3.24E-13
ENSG00000169594	BNC1	-0.536	1.87E-13
ENSG00000140450	ARRDC4	-0.537	5.53E-08
ENSG00000109321	AREG	-0.539	9.84E-14
ENSG00000161960	EIF4A1	-0.540	1.39E-03
ENSG00000013588	GPRC5A	-0.546	1.97E-12
ENSG00000164949	GEM	-0.558	1.23E-03
ENSG00000167772	ANGPTL4	-0.560	2.02E-07
ENSG00000185742	C11orf87	-0.565	1.65E-02
ENSG00000144355	DLX1	-0.571	9.18E-04
ENSG00000136244	IL6	-0.572	5.77E-05
ENSG00000187908	DMBT1	-0.577	1.01E-04
ENSG00000198719	DLL1	-0.580	3.28E-04
ENSG00000007944	MYLIP	-0.582	2.59E-03
ENSG00000197182	MIRLET7BHG	-0.588	4.41E-04
ENSG00000188064	WNT7B	-0.601	9.96E-07
ENSG00000187193	MT1X	-0.604	8.10E-06
ENSG00000127152	BCL11B	-0.609	4.12E-04
ENSG00000173848	NET1	-0.612	1.32E-15
ENSG00000189120	SP6	-0.615	7.47E-05
ENSG00000180758	GPR157	-0.620	3.02E-07
ENSG00000234289	H2BFS	-0.621	1.03E-02
ENSG00000106366	SERPINE1	-0.623	7.73E-10
ENSG00000178919	FOXE1	-0.625	3.00E-04
ENSG00000118515	SGK1	-0.629	2.21E-10
ENSG00000124225	PMEPA1	-0.639	1.67E-11
ENSG00000164379	FOXQ1	-0.640	7.62E-06
ENSG00000170577	SIX2	-0.641	9.63E-09
ENSG00000234667	ACTBP13	-0.644	5.04E-02
ENSG00000169184	MN1	-0.646	1.04E-10
ENSG00000177494	ZBED2	-0.647	2.90E-12
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ENSG00000187566	NHLRC1	-0.655	9.94E-03
ENSG00000163735	CXCL5	-0.655	6.36E-03
ENSG00000203999	LINC01270	-0.657	3.08E-02
ENSG00000247626	MARS2	-0.662	2.30E-07

ENSG00000087494	PTHLH	-0.669	1.68E-14
ENSG00000137801	THBS1	-0.673	8.80E-15
ENSG00000154764	WNT7A	-0.684	6.65E-06
ENSG00000152518	ZFP36L2	-0.691	9.42E-13
ENSG00000105649	RAB3A	-0.692	3.40E-02
ENSG00000119938	PPP1R3C	-0.693	2.30E-04
ENSG00000204316	MRPL38	-0.696	3.15E-02
ENSG00000142178	SIK1	-0.696	1.56E-02
ENSG00000135048	TMEM2	-0.698	3.84E-13
ENSG00000246334	PRR7-AS1	-0.701	2.29E-02
ENSG00000119986	AVPI1	-0.702	2.20E-12
ENSG00000156804	FBXO32	-0.705	5.03E-10
ENSG00000179846	NKPD1	-0.724	7.32E-04
ENSG00000095752	IL11	-0.728	5.62E-05
ENSG00000158246	FAM46B	-0.734	5.74E-10
ENSG00000180730	SHISA2	-0.736	7.07E-04
ENSG00000170385	SLC30A1	-0.736	5.60E-13
ENSG00000100985	MMP9	-0.737	1.52E-07
ENSG00000143333	RGS16	-0.743	3.13E-03
ENSG00000123689	G0S2	-0.746	6.16E-16
ENSG00000185650	ZFP36L1	-0.795	2.01E-17
ENSG00000136997	MYC	-0.796	5.12E-15
ENSG00000187689	AMTN	-0.830	3.19E-02
ENSG00000134259	NGF	-0.833	8.86E-03
ENSG00000177283	FZD8	-0.837	1.08E-09
ENSG00000145358	DDIT4L	-0.841	1.01E-03
ENSG00000015479	MATR3	-0.845	4.61E-03
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ENSG00000106003	LFNG	-0.904	9.83E-07
ENSG00000139874	SSTR1	-0.932	5.15E-04
ENSG00000144476	ACKR3	-0.936	4.01E-08
ENSG00000162892	IL24	-0.950	9.02E-10
ENSG00000154734	ADAMTS1	-0.966	1.06E-12
ENSG00000185112	FAM43A	-0.978	3.49E-07
ENSG00000170961	HAS2	-1.014	1.58E-10
ENSG00000178726	THBD	-1.072	1.07E-18
ENSG00000120875	DUSP4	-1.078	5.26E-19
ENSG00000174343	CHRNA9	-1.092	9.89E-08
ENSG00000188042	ARL4C	-1.142	5.48E-17
ENSG00000117318	ID3	-1.163	1.33E-15
ENSG00000128045	RASL11B	-1.166	2.36E-06
ENSG00000185338	SOCS1	-1.178	1.89E-04

ENSG00000107984	DKK1	-1.211	1.99E-16
ENSG00000134363	FST	-1.258	1.61E-17
ENSG00000173391	OLR1	-1.271	6.82E-06
ENSG00000120129	DUSP1	-1.295	1.68E-19
ENSG00000119508	NR4A3	-1.325	4.82E-06
ENSG00000078401	EDN1	-1.400	1.19E-11
ENSG00000124216	SNAI1	-1.421	6.17E-12
ENSG00000180447	GAS1	-1.452	1.15E-18
ENSG00000116741	RGS2	-1.553	4.51E-18
ENSG00000189431	RASSF10	-1.704	8.50E-09
ENSG00000223361	FTH1P10	-2.193	4.46E-02